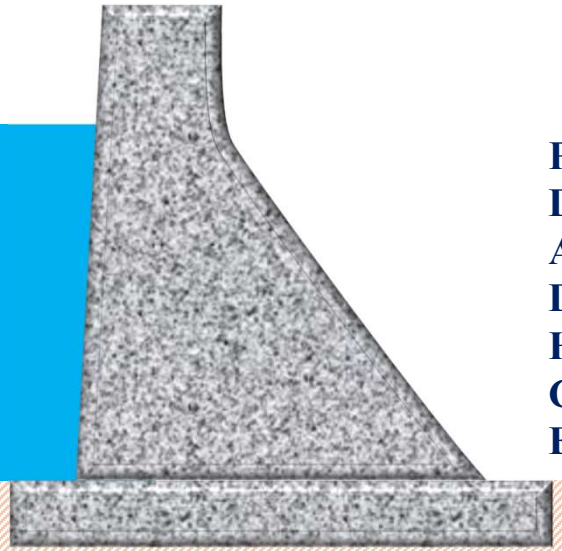
9th INDIA INTERNATIONAL WATER WEEK - 2026

Sub-Theme: 3. Collaboration for Optimal Use of Water Resources.
Topic: TF6-International Collaboration in the Field of Climate Related Risk

सत्यमेव जयते
Ministry of Jal Shakti
Government of India

Presentation on

Climate Change and Aging Reservoir Infrastructure: Emerging Challenges for Dam Safety in India



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Motivation

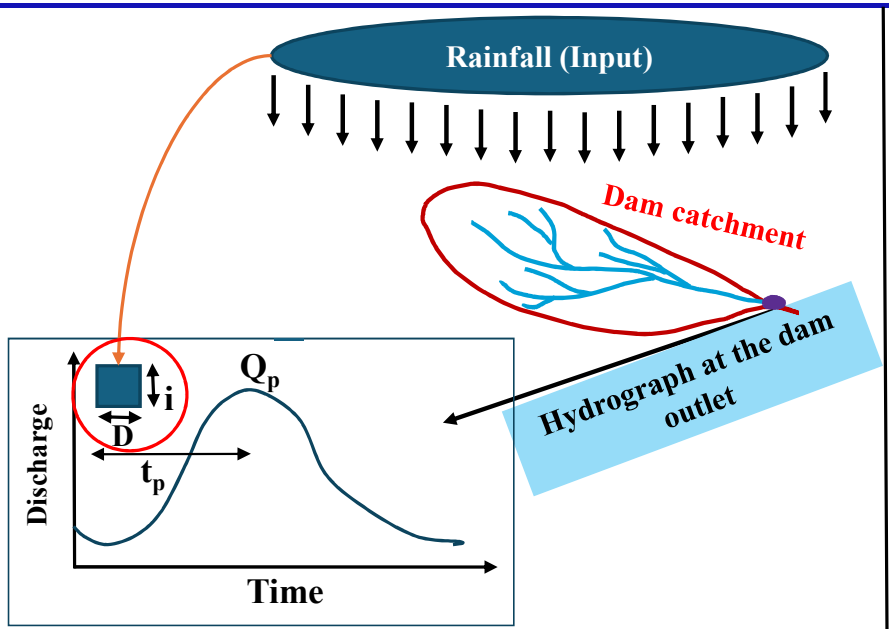


Figure 1. Concept of Hydrograph

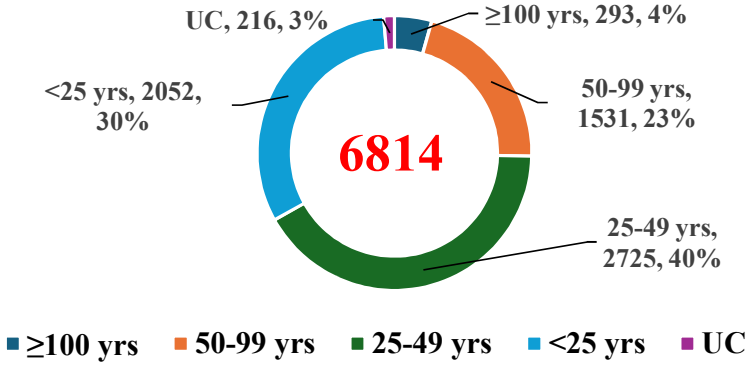
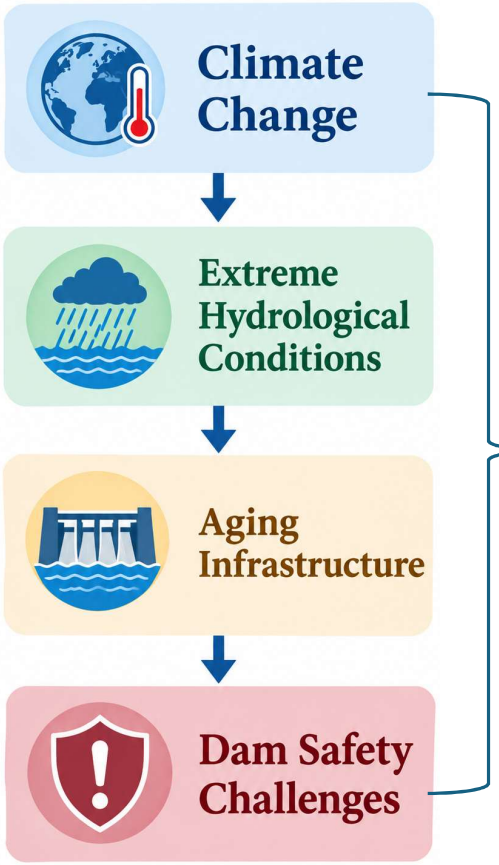


Figure 2. Age-wise specified dams (Source: NRSD, 2026)



Aging Dams + Changing Climate

=

New Challenges for Dam Safety

Are dams safe under extreme rainfall events in a changing climate ?

Objectives

The main focus is to investigate whether aging dams in India are increasingly exposed to rainfall extremes that differ from the hydro-climatic conditions considered during their original design phase.

1. To assess changes in short-duration and accumulated extreme rainfall characteristics (RX1day, RX3day, and RX5day) between the historical design era and present-day climate conditions at selected major dams in India.

2. To evaluate the frequency of occurrence of extreme rainfall events under present-day conditions relative to those prevailing during the original dam design period.

3. To estimate and compare rainfall return levels associated with selected return periods using extreme value analysis to determine whether present-day extremes exceed historical design-era conditions.

Study Area

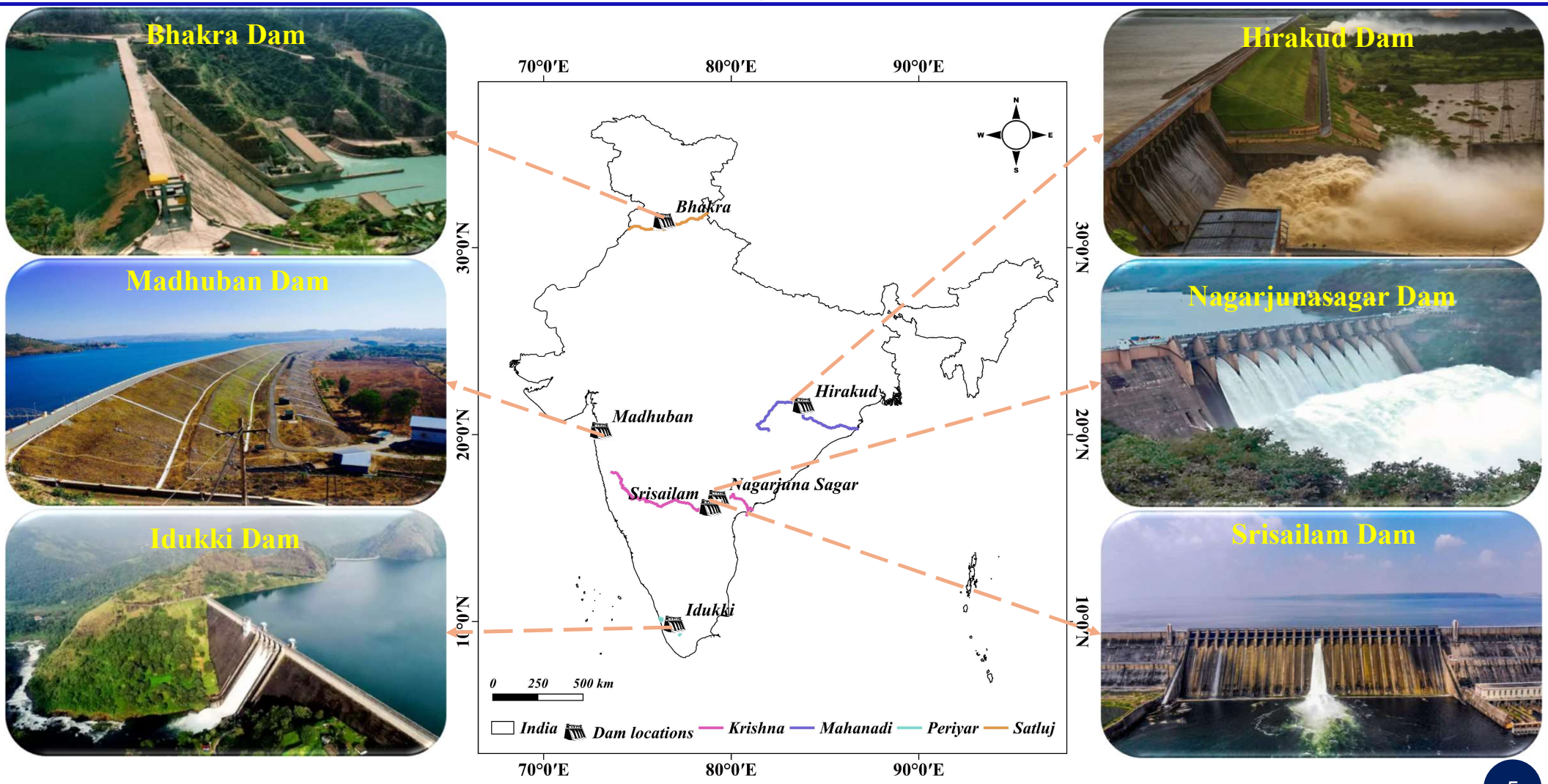


Figure 3. Geographical locations of selected dams

Study Area

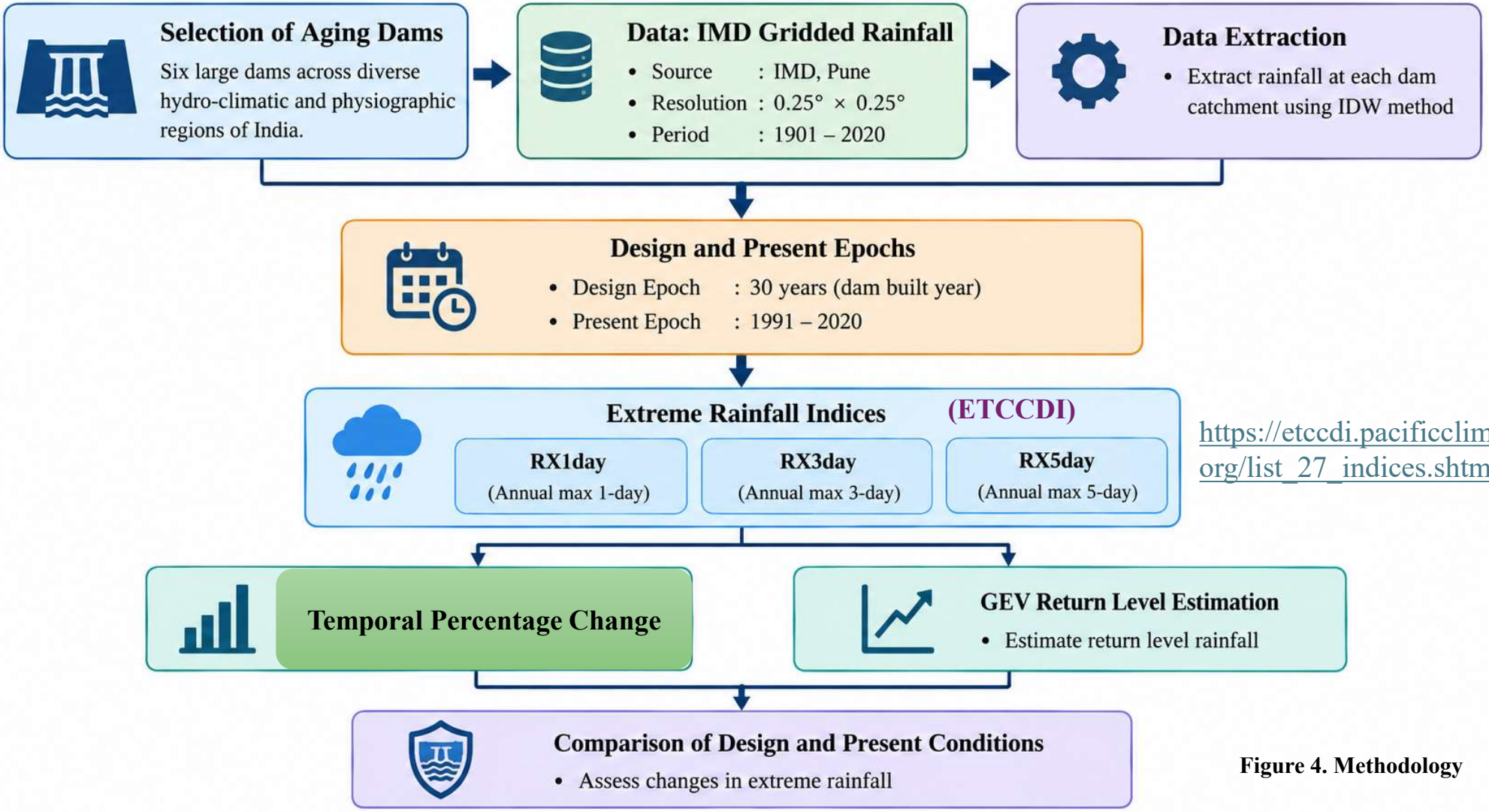
Table 1. Salient Features of Selected Large Reservoirs (https://dharma.ndsa.gov.in/#/national-register-of-specified-dams-(nrsd))

Dam Name	River	Year of built	Age (years)	Longitude (°E)	Latitude (°N)	Height (m)	Length (m)	Gross storage capacity (MCM)	Designed spillway capacity (m^3/s)
Nagarjuna Sagar	Krishna	1955	71	79°18'47"	16°34'23"	125	4865	8837	43325
Hirakud	Mahanadi	1957	69	83°52′30″	21°32′02″	61	2580	8136	42450
Bhakra	Satluj	1963	63	76°26'00"	31°24'40"	226	518	9868	5587
Idukki	Periyar	1974	52	76°58'35"	9° 50'37"	169	366	1997	4528
Madhuban	Damanganga	1973	53	73°03'37"	20°11'37"	59	352	525	17443
Srisailam	Krishna	1984	42	78°53'47"	16° 5'13"	145	512	6111	38369

Note:

1. **All dams are multi-purpose projects.**
2. **Definition of Large dam: A dam with a height of 15 metres or greater from lowest foundation to crest.**

Methodology



https://etccdi.pacificclimate.org/list_27_indices.shtml

Figure 4. Methodology

Results and Discussions

Table 2. Percentage Change in Rainfall magnitudes of Extreme Rainfall Indices between Design and Present epochs

Dam Name	RX1day			RX3day			RX5day		
	DE (mm)	PE (mm)	%change	DE (mm)	PE (mm)	%change	DE (mm)	PE (mm)	%change
Nagarjuna Sagar	81	89	**10**	118	132	**12**	139	151	**9**
Hirakud	154	159	**3**	244	253	**4**	286	287	**0**
Bhakra	78	83	**7**	133	150	**13**	161	188	**17**
Idukki	70	97	**38**	143	173	**21**	197	219	**11**
Madhuban	190	192	**1**	384	393	**2**	497	518	**4**
Srisailam	57	74	**29**	95	120	**26**	114	137	**21**

DE-Design Epoch (preceding 30-year from dam built year); PE-Present Epoch (1991-2020)

Results and Discussions

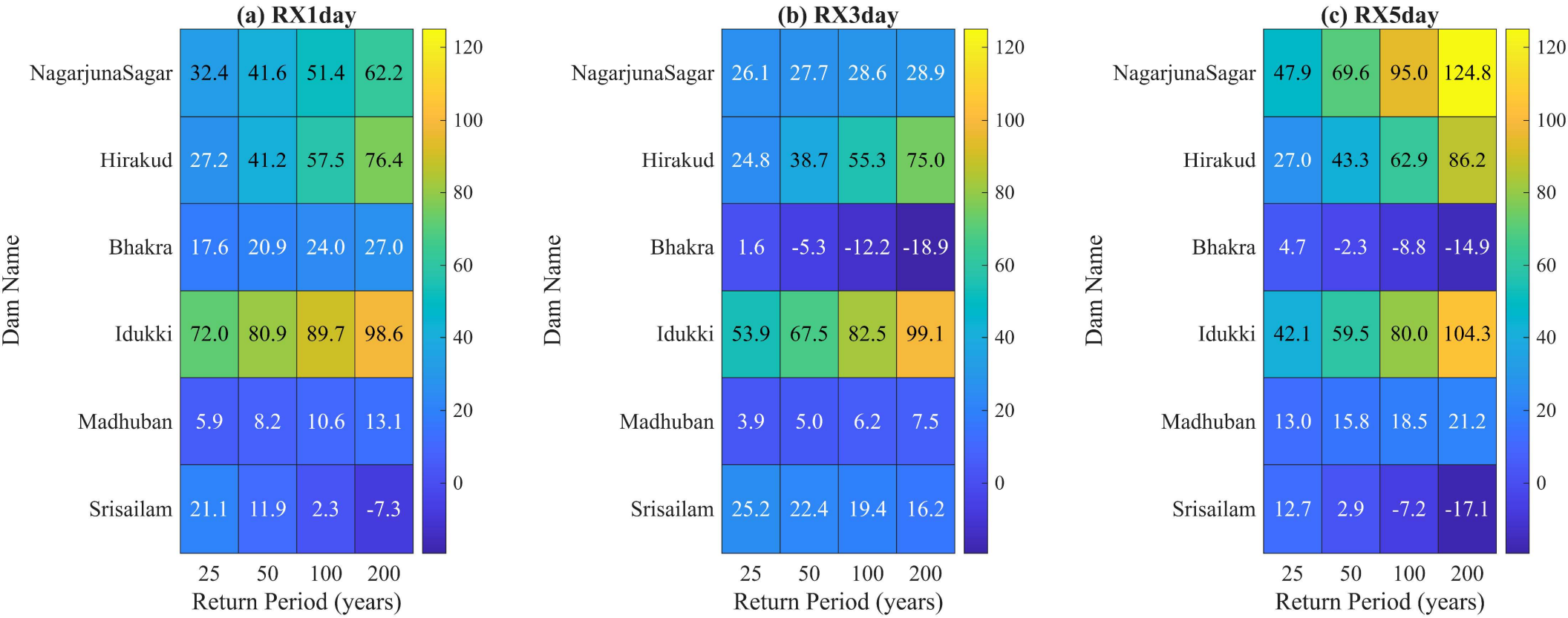


Figure 5. the percentage changes in the estimated rainfall magnitudes of RX1day, RX3day, and RX5day between the design epoch and present epoch for return periods of 25, 50, 100, and 200 years.

Results and Discussions

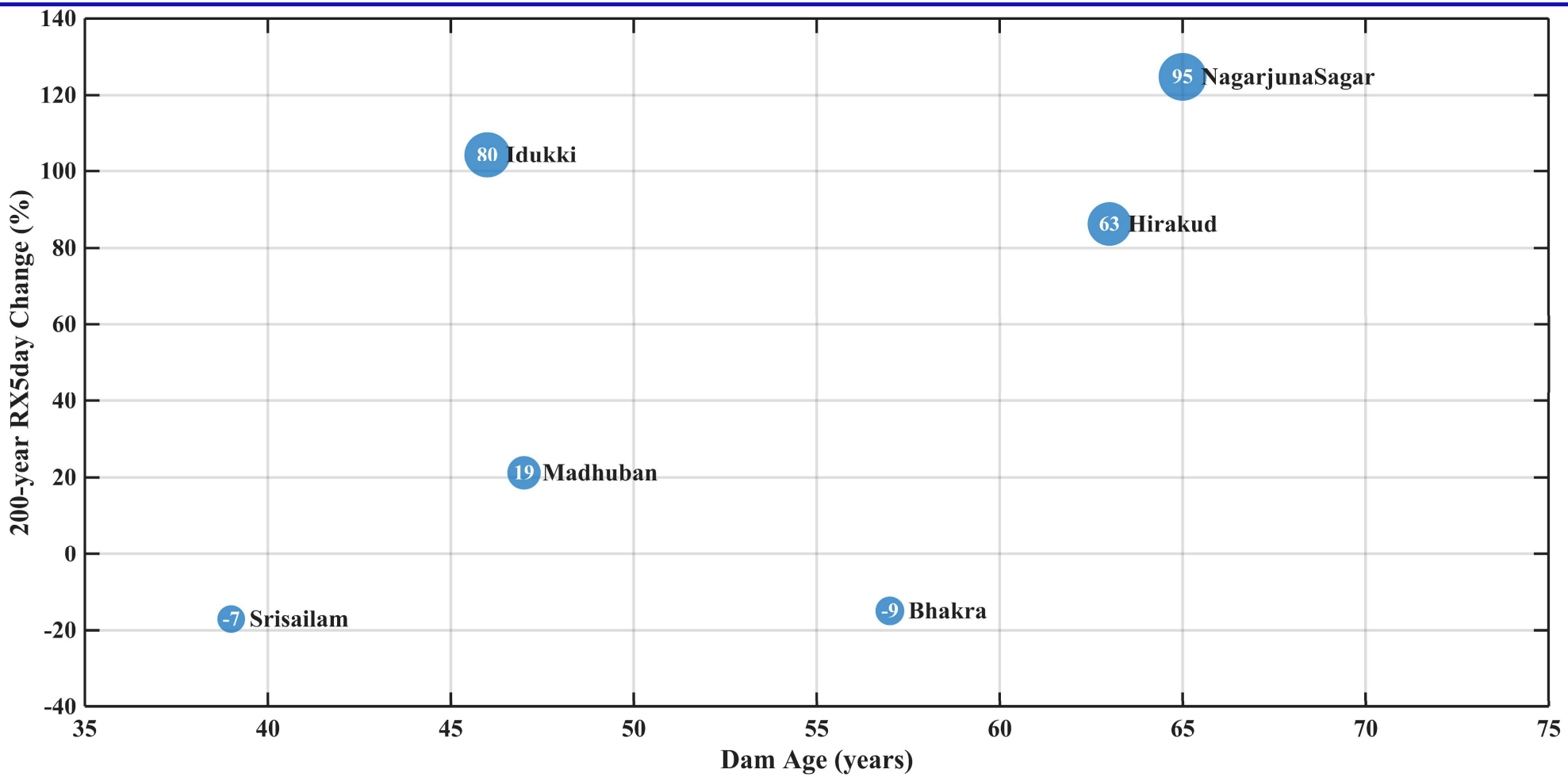
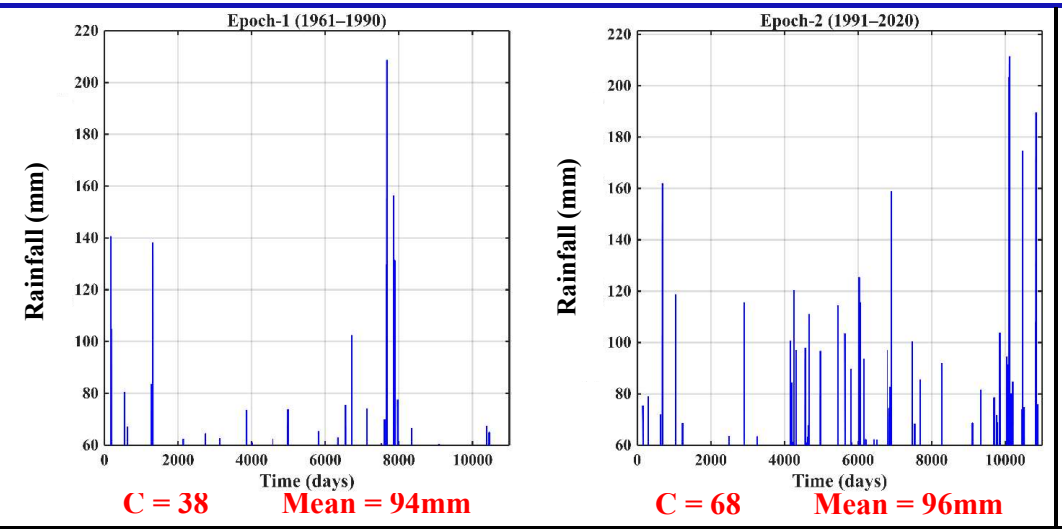
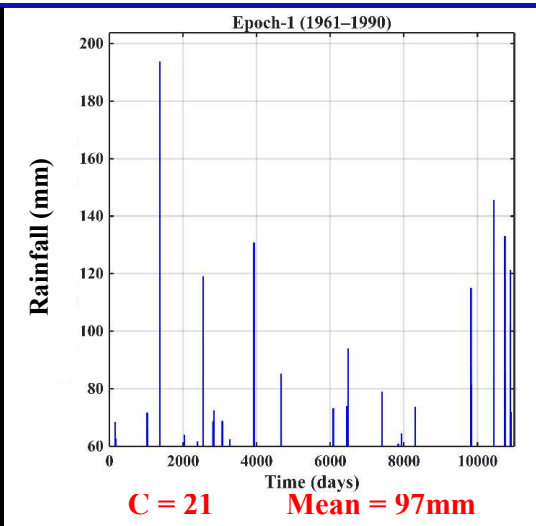
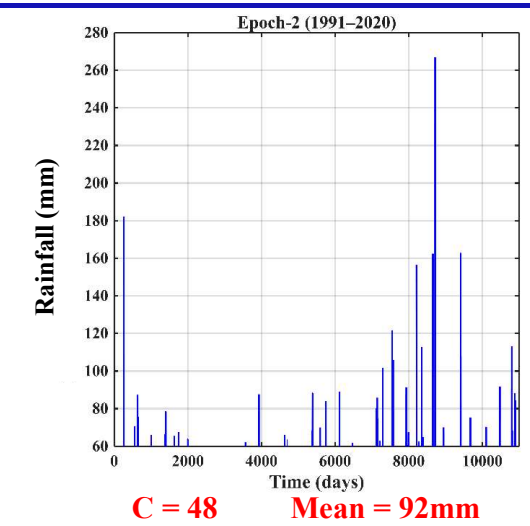


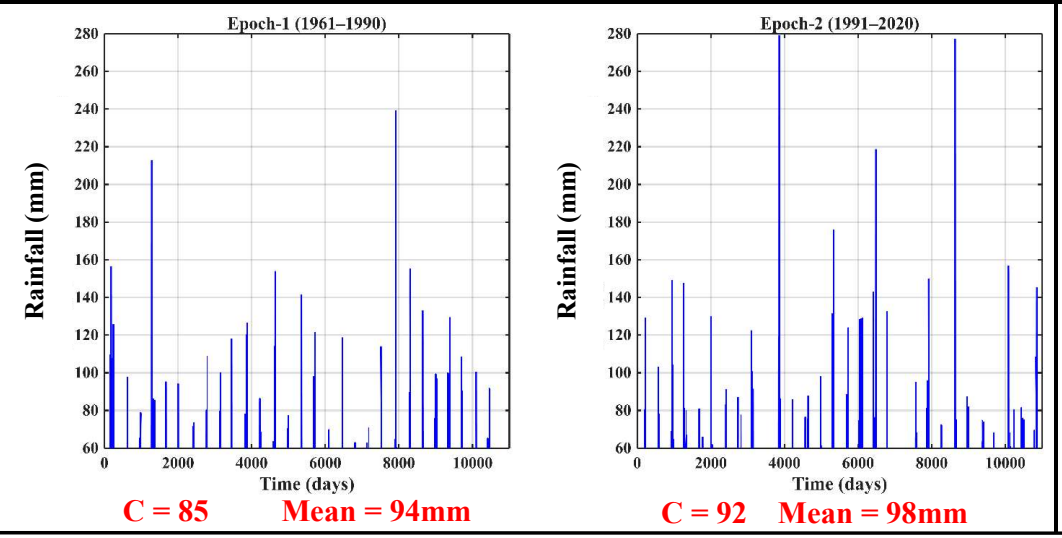
Figure 6. Comparative visualization of climate exposure among selected aging dams in India. . Bubble sizes are proportional to the percentage changes in 100-year RX5day rainfall magnitudes, and the values displayed within the bubbles denote the corresponding 100-year RX5day percentage changes.

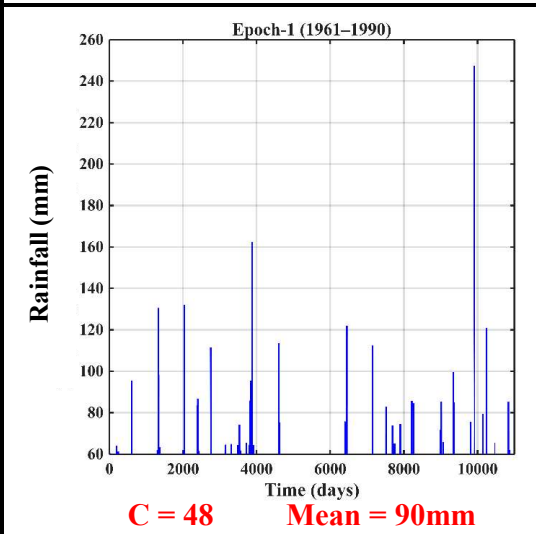
Results and Discussions











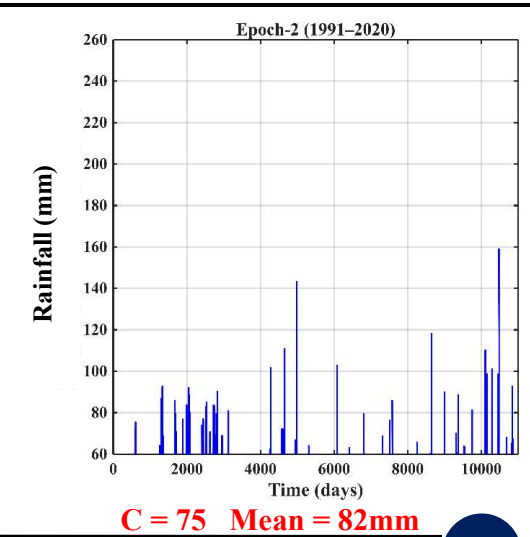


Figure 7. Frequency of heavy rainfall events (HREs) per epoch for (a) Idukki, (b) Nagarjuna Sagar, (c) Hirakud, (d) Bhakra. Here, C is count of HREs ≥ 64.5mm, and Mean is mean rainfall of HREs.

Key Conclusions and Future Scope

Key Conclusions

The key conclusions from this study are as follows:

1. **Extreme rainfall characteristics have changed between the design and present epochs across the selected dam catchments.**
2. **Multi-day extremes (RX3day and RX5day) showed stronger increases at several catchments, indicating more persistent rainfall events.**
3. **GEV analysis indicated higher rainfall magnitudes at longer return periods for several catchments, suggesting intensified rare extreme events.**
4. **Changes are spatially heterogeneous, highlighting the need for site-specific assessment of evolving rainfall extremes for dam safety.**

Future Scope

Reassess the adequacy of existing design floods for aging reservoirs under changing rainfall extremes.

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Thank You

Dam Failures



Tiware Dam
02nd July 2019



Annamayya Dam
19th November 2021

POWER PROJECTS AFFECTED BY THE FLASH FLOOD

BHADRA 10, 2083

RASUWA

S.N.	PROJECT NAME	CAPACITY
1.	Upper Trishuli-1	216 MW
2.	Rasuwagadhi Hydropower Project	111 MW
3.	Rasuwa–Bhotekoshi	120 MW
4.	Upper Mailung-A	6.42 MW
5.	Sanjen Khola	78 MW
6.	Langtang Khola	20 MW
7.	Chilime Hydropower Project	22 MW
8.	Mailung Khola	5 MW

TOTAL (RASUWA): 8 PROJECTS | 578.42 MW

NUWAKOT

S.N.	PROJECT NAME	CAPACITY
1.	Trishuli Hydropower Project	24 MW
2.	Devighat Hydropower Project	14.1 MW
3.	Upper Trishuli-3A	60 MW
4.	Upper Trishuli-3B	37 MW
5.	Middle Trishuli Ganga	15.6 MW
6.	25 MW Solar Project	25 MW

TOTAL (NUWAKOT): 6 PROJECTS | 175.70 MW

14 TOTAL PROJECTS | **754.12 MW** TOTAL CAPACITY

Source: Initial Report, Nepal Electricity Authority (NEA)
Date: Bhadra 10, 2083

Hydropower Diares