Climate Action in Water Sector

A global issue that affects us all

Presented By

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THE NEW CLIMATE REALITY

WHAT WE KNOW ABOUT CLIMATE CHANGE

In the future, it will be different from what we think now

01

Living with extremes may become the norm for some regions

02

Drought/ extreme drought, more flood events

03

Less time spent under conditions that are currently thought to be “normal”

04

IMD Statement on the Climate of India during 2025

Annual Temperature

- +0.28°C above 1991–2020 average
- 8th warmest year since 1901
- Warmest year on record: 2024 (+0.65°C)

Seasonal Temperature Anomalies

(compared to long-term average)

- Winter (Jan–Feb): +1.17°C
- Pre-monsoon (Mar–May): +0.29°C
- Monsoon (Jun–Sep): +0.09°C (~normal)
- Post-monsoon (Oct–Dec): -0.10°C (~normal)

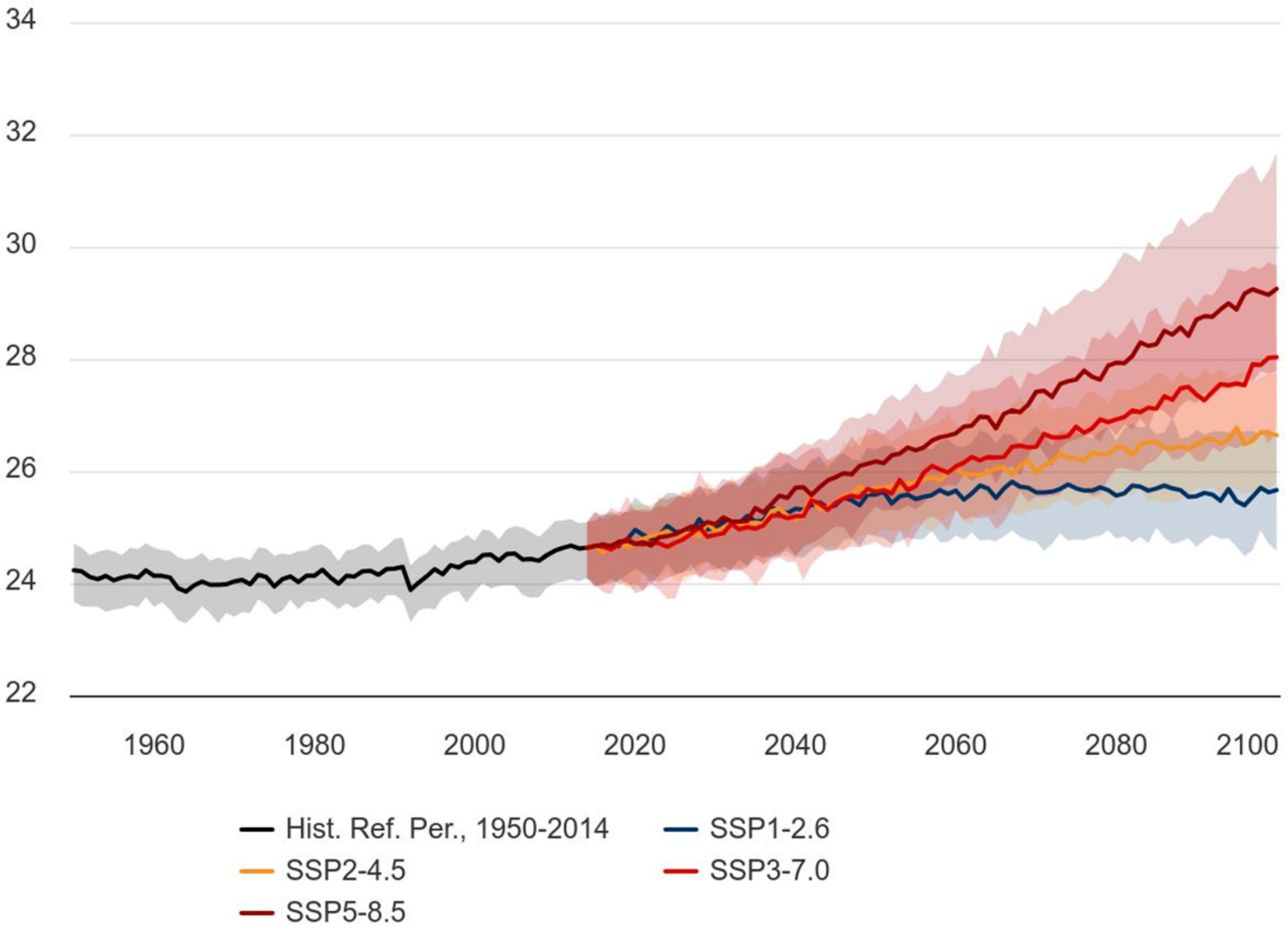
Rainfall – Above Normal Overall

- Annual: 1274 mm (110% of Long Period Average (LPA)
- Winter: 52% of LPA
- Pre-monsoon: 142% of LPA
- Monsoon: 108% of LPA
- Post-monsoon: 111% of LPA

Extreme Weather Events Reported Across India

- Cyclones
- Cloudbursts
- Floods
- Landslides
- Thunderstorms
- Lightning
- Droughts

Projected Average Mean Surface Air Temperature India; (Ref. Period: 1995-2014), Multi-Model Ensemble



Rainfall Pattern: 2025

Nationwide Surplus

India’s total annual rainfall for 2025 was 110% of the Long Period Average (LPA), and the principal Southwest Monsoon season was above normal at 108% of LPA.

Record-Breaking Early Rains

The country experienced historic pre-monsoon rainfall, with May 2025 being the wettest May since 1901 and the entire pre-monsoon season ranking as the third-highest on record.

Significant Regional Imbalance

While Northwest, Central, and South Peninsular India saw large excess rainfall (127%, 115%, and 110% of LPA, respectively), East & Northeast India received a notable deficit of only 80% of its LPA.

Post Monsoon Rainfall 2025

Month	Actual Rainfall, mm	Normal Rainfall, mm	% Departure from Normal
Oct 2025	112.2	75.4	+48.8
Nov 2025	17	29.7	-42.8
Dec 2025	4.9	15.9	-68.9
Post Monsoon 2025	134.2	121	+10.9

The Early Arrival: Monsoon 2025 Timeline

🔑 South Andaman Sea & Nicobar Islands
Arrived: 13 May 2025
Normal Date: ~19 May
Status: 6 days early

🔑 Kerala (Monsoon Onset)
Arrived: 24 May 2025
Normal Date: 1 June
Status: 8 days early

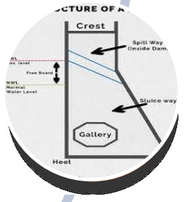
🔑 Entire Country Coverage
Achieved: 29 June 2025
Normal Date: 8 July
Status: 9 days early

Climate Change effect on dam safety

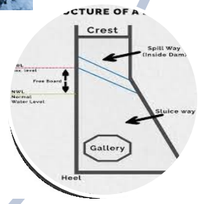
01 Increase in the value of Design flood

02 Landslide in reservoirs occurrence changes

03 Impacts of debris yielded with floods on dams and structures (gates)

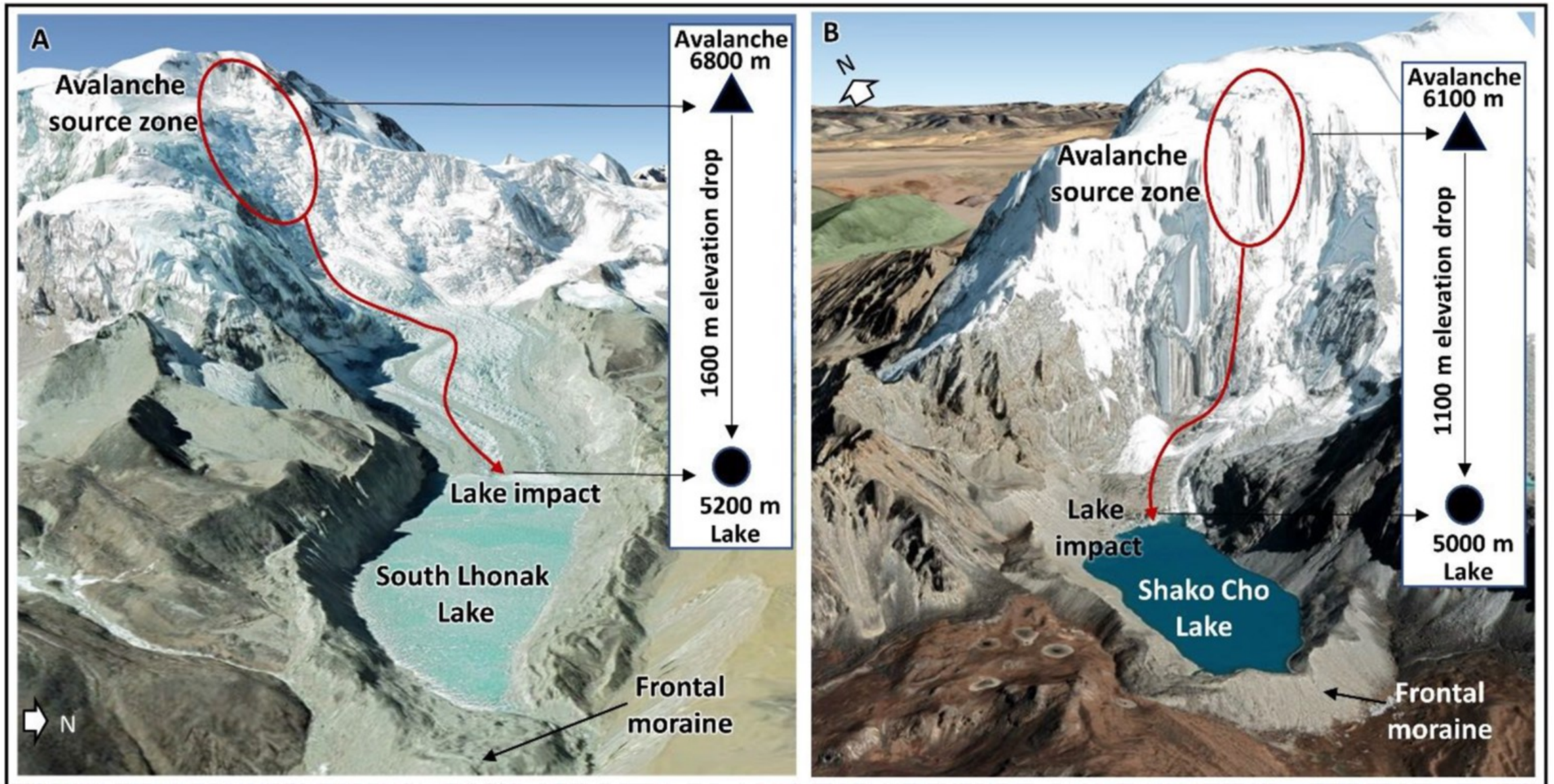


04 Variability of reservoir level change that may affect structural behaviour of dams



05 change in average or extreme temperature of air/water affects Structural behaviour of dams and appurtenant structure

Climate Change effect: GLOF affecting dam safety



How Increased Flood Peak Affects?

Hydraulic structures designed and operated according to past climate and hydrological conditions, are susceptible to overtopping.

PEDDAVAGU DAM, TELANGANA

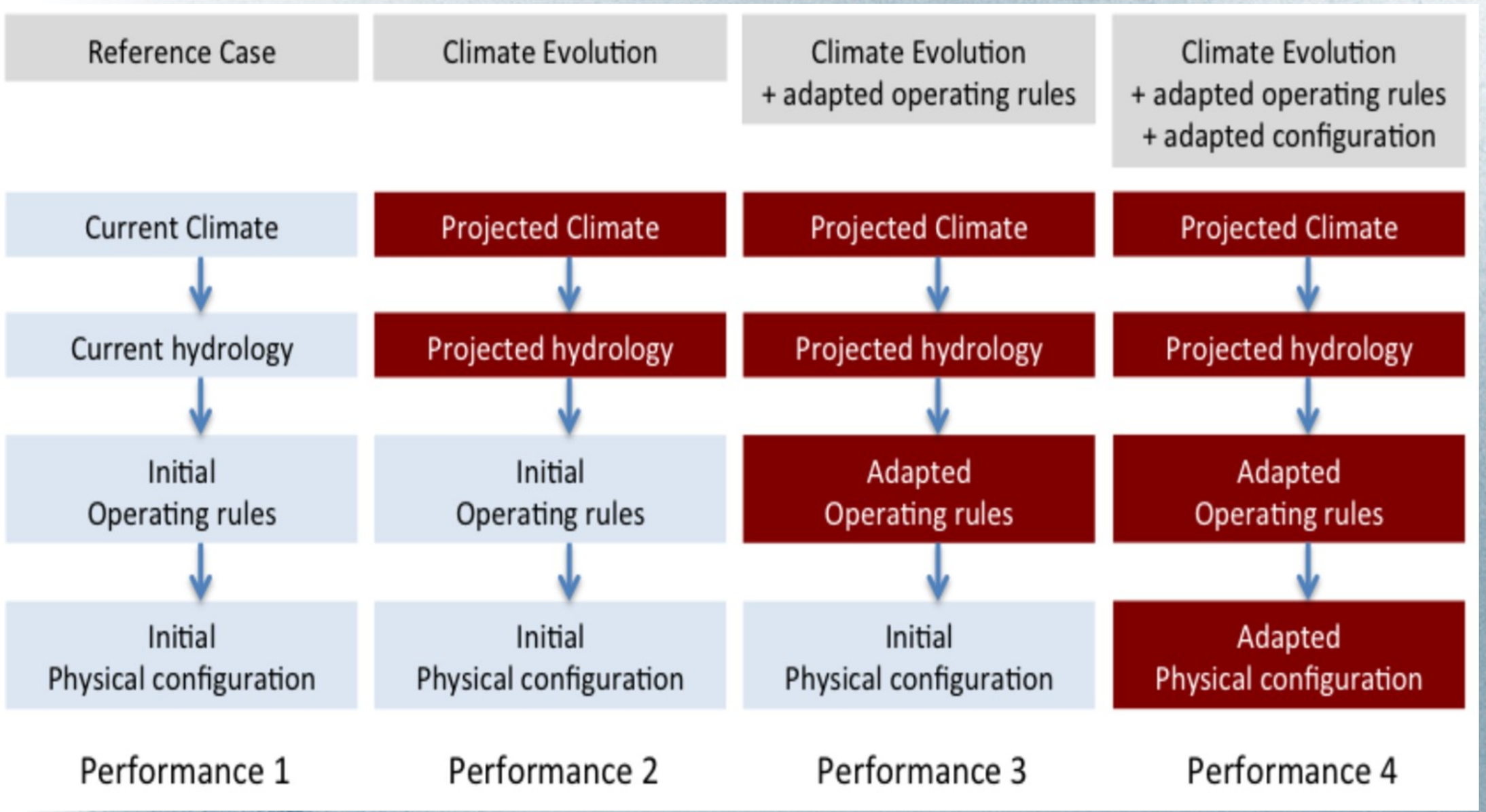
In the light of potential climate and hydrological changes, it is recommended to revisit the adequacy of the hydraulic structures and their operations

VENIKA DAM, CHHATTISGARH

Specified Dams Portfolio Height Wise

Range of Height	No. of Dams
Between 10m to15m	2460
Between 15m to 30m	3440
Between 30m to 100m	702
More than 100m	26

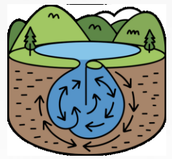
Climate Action



RUNOFF DETERMINATION

01 Choose and calibrate a hydrological model

02 Simulate the future hydrological regime (with climate scenarios

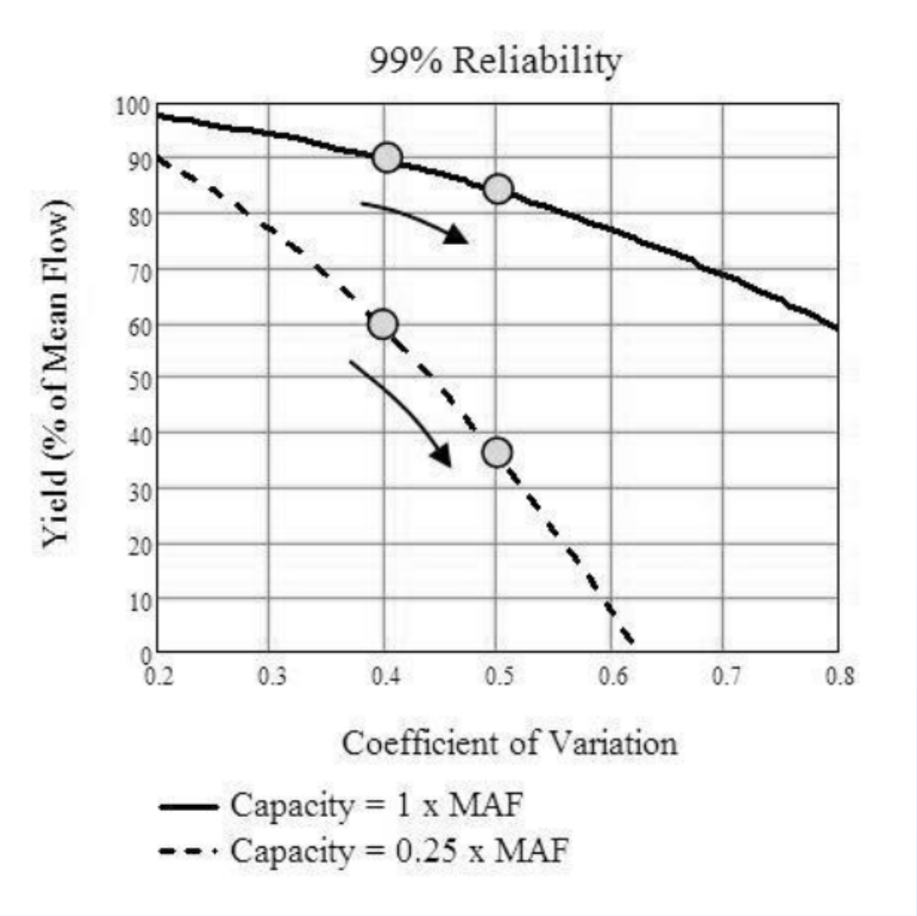


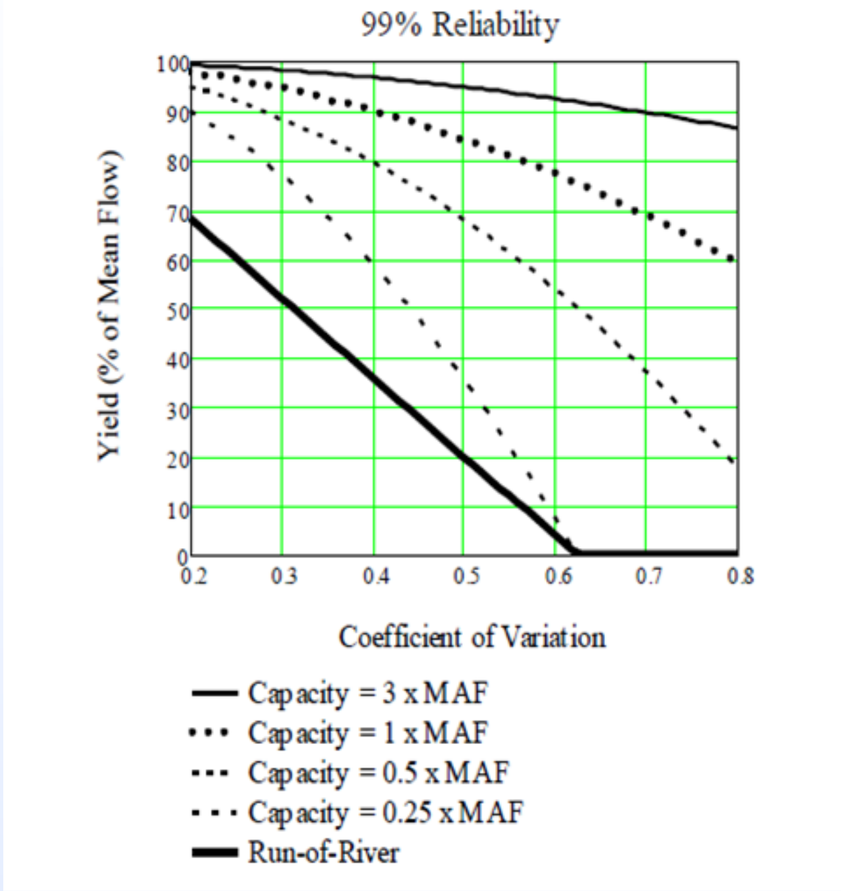
03 Select a sub-sample of hydrological simulations that covers the uncertainty

04 Analyse the impacts on specific variables of interest (mean annual flood volume, flood peak, timing of the flood peak

05 If expected impacts are not significant, there is no need to adapt.If the expected impacts are significant, one may or may not go through management tools

Reservoir Storage

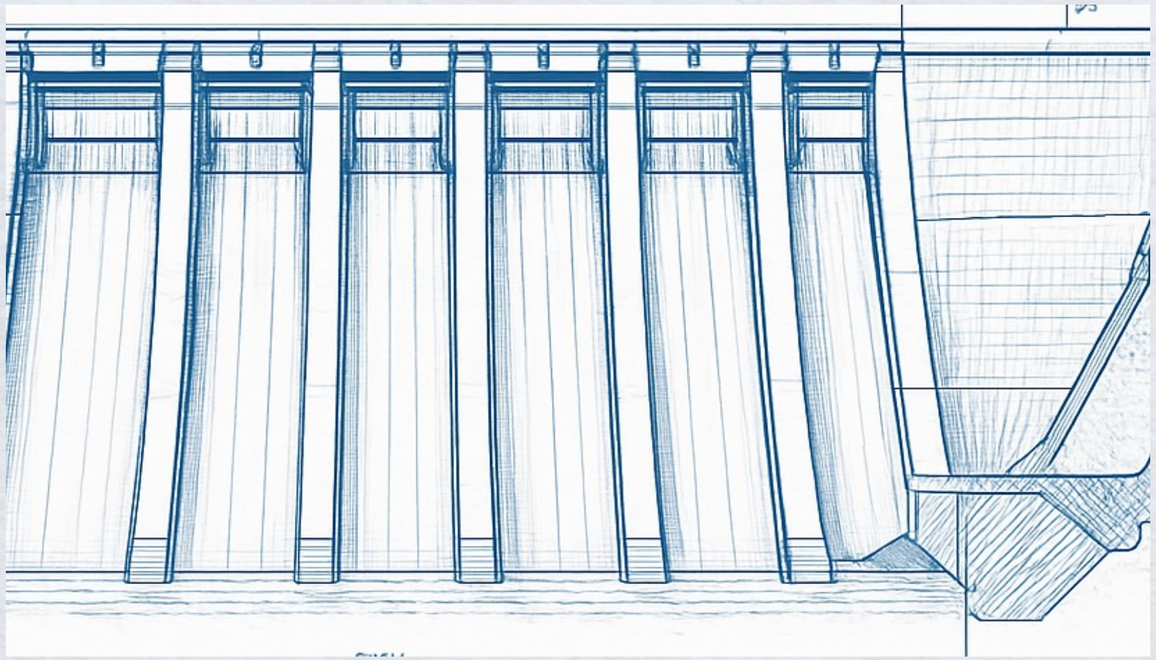




Source: ICOLD Technical Bulletin 169

- Assured water supply, for hydro power or for any other purpose, is done by providing storages.
- A higher storage is less sensitive to climate change variation as shown in the graph.
- In view of the above. Run of the River (RoR)schemes are likely to suffer functionally more as compared to storage schemes.

Potential Structural Measures



NEW DAM DESIGN

- DESIGN SPILLWAY FOR THE ENHANCED CAPACITY AND THEY SHOULD BE GATED ONE TO PROVIDE REGULATION OF THE FLOW
- KEEP PROVISION OF EMERGENCY SPILLWAYS
- INCREASE THE AMOUNT OF FREEBOARD ABOVE TOP WATER LEVEL IN ORDER TO ACCOMMODATE PREDICTED INCREASES IN FLOOD RISE AND WAVE SURCHARGE VALUES.
- REPLACE OR REINFORCE UPSTREAM SLOPE PROTECTION SUCH AS RIP-RAP TO PROVIDE SATISFACTORY EROSION PROTECTION UNDER INCREASED DYNAMIC LOADING FROM WAVES.
- PLAN FOR STORAGE RESERVOIRS IN PLACE OF ROR SCHEMES
- Non overflow section of dam may also be design as overflow section for extreme flood event

Potential Structural Measures

Existing Dams

- INCREASE IN THE CAPACITY OF THE SPILLWAY WORKS AND/OR PROVIDE EMERGENCY SPILLWAY AS PER SITE CONDITION
- ADD CONTROLLABLE GATES TO FREE OVERFLOW SPILLWAYS IN ORDER TO PROVIDE GREATER REGULATION OF FLOOD PEAKS
- MODIFY THE DIMENSION OF CANALS OR TUNNELS THAT ARE FOR WATER TRANSFER
- CREATE NEW UPSTREAM STORAGE RESERVOIRS AND RE-CONSIDER THE MULTI-PURPOSE POTENTIAL OF NEW RESERVOIR PROJECTS
- MODIFY THE ACTIVE STORAGE CAPACITY OF RESERVOIRS BY INCREASING THE HEIGHT OF THE STORAGE DAM AND/OR RAISING THE SILL LEVEL OF THE OVERFLOW WORKS
- REPLACE OR REINFORCE UPSTREAM SLOPE PROTECTION SUCH AS RIP-RAP TO PROVIDE SATISFACTORY EROSION PROTECTION UNDER INCREASED DYNAMIC LOADING FROM WAVES

Functional Adaptation Measures

01 Developing or improving hydrological forecasting tools

02 Development and application of appropriate measures to deal with extreme hydrological events

03 Bringing changes to operating rules such as revised reservoir level limits in order to provide an increased flood storage buffer

04 Modi… spec…

05 Modification to the price of power, energy or water. This could have an impact upon the extraction of water for irrigation, industrial, and other consumptive activities

06 Better coordination of the operation of the project with other water uses in the watershed

07 Modification to rules that have an influence upon recreation, irrigation, water supply and industrial water …

08 …

09 Regulation of reservoirsholistically at basin level to develop and apply improved operating strategies

Korea: Hydrological Stability Enhancement Project of Existing Dams

Lessons from other countries

- Climate modelling indicates that the Republic of Korea will experience great fluctuations in water resource availability and rainfall intensity in the future, and in a country where approximately two thirds of annual rainfall occurs over three month period the intensity of rainfall events is also predicted to increase.
- Recent studies have shown that estimates of PMPs have increased by as much as 300% in some catchments and as a result 23 out of 27 major dams studies are to be remediated to provide security against extreme flood events. The remedial works program has a budget of USD 2.2 billion and commenced in 2003.
- In addition to flood capacity, the changed rainfall patterns and storm intensities are also likely to have a detrimental effect on water quality due to high sediment loads in runoff into reservoirs. This in turn has the potential to impact on hydropower facilities, fisheries, drinking water quality and tourism. A number of mitigation measures are being undertaken both in the catchments and in the reservoirs of five dams to minimise the potential impacts of increased inflow turbidity, at an estimated cost of an additional USD 1 billion.

Japan: Kumano River Project

Lessons from other countries

- This is an example of operational adaptation of an existing project and does not involve structural change. In Japan the owners of utility storage reservoirs for hydropower or water supply purposes are not legally obliged to contribute to flood control.
- The adaptation project that was implemented has involved a modified operating regime whereby an "interim target water level" that is lower than the specified ‘discharge preparation water level’ has been introduced in order to increase the flood storage volume that is available. Drawdown to achieve the interim target water level is performed by generation discharge only. In order to determine the criteria to begin the drawdown, it is necessary to accurately predict the total average rainfall in the catchment that will occur over the next 2 to 3 day period.

CONCLUSION

- Impact to be felt severely in developing countries with agrarian economies
- India with surging population increased industrialization and associated high demand for fresh water, food and energy becomes highly vulnerable
- Dams and their reservoir shall provide a vital role in the changing climate scenarios.
- Existing dams safety has to be ensured by both structural and functional adaptation measures.
- A basin level approach is required for the reservoir operations for which states have to share the basin level data with each other.
- Creation of the inventory of all water resource projects both at central and state level.
- Most of the ungated earthen/rockfill dams are vulnerable due to climate change.

राष्ट्रीय बाँध सुरक्षा प्राधिकरण
National Dam Safety Authority
NDSA

THANK YOU