

# C W P R S & DAM SAFETY EVALUATION

|Single-Window Technical Support Aligned with the NDSA Framework|

Supporting Dam Owners in Comprehensive Dam Safety Evaluation (CDSE)

One Institution | Integrated Expertise | Safe Dams



Central Water and Power Research Station  
DoWR, RD & GR | Ministry of Jal Shakti | Govt. of India

# Why Dam Health Monitoring Matters?

India possesses one of the largest dam infrastructures in the world, with over 6,400 specified dams supporting irrigation, drinking water supply, hydropower generation and flood moderation. Over decades of operation, these structures are subjected to ageing, material deterioration, sedimentation, evolving hydrological regimes, seismic influences and increasing climate variability.

Periodic and comprehensive dam health assessment is essential to ensure continued safety, reliability and performance. Such assessments enable early identification of distress, evaluation of structural and hydraulic adequacy, review of operational practices and preparedness for extreme events, thereby supporting timely maintenance, rehabilitation and risk mitigation.

Recognising this national imperative, the Dam Safety Act, 2021 provides a statutory basis for uniform, systematic and scientific dam safety management across the country.

**"Safeguarding India's 6,400+ dams through systematic assessment and rehabilitation is a national imperative."**

## National Framework for Dam Health Monitoring

*Statutory Framework under the Dam Safety Act, 2021*

The Dam Safety Act, 2021 establishes a comprehensive institutional and regulatory framework for dam safety in India. The Act mandates dam owners to undertake regular inspection, hazard classification, preparation of Emergency Action Plans and Comprehensive Dam Safety Evaluation (CDSE) of specified dams.

To operationalise the Act, a multi-tier institutional structure has been established comprising the National Committee on Dam Safety (NCDS) and the National Dam Safety Authority (NDSA) at the national level and State Committees on Dam Safety (SCDS) and State Dam Safety Organisations (SDSOs) at the State level.

The National Dam Safety Authority (NDSA) has issued detailed Standard Operating Procedures (SOPs) for conducting CDSE, defining a uniform 13-point technical mandate covering structural, hydraulic, geotechnical, seismic, operational and safety management aspects.

Effective implementation of these SOPs requires multidisciplinary technical expertise, coordinated investigations and integration of field data, analytical studies and professional judgement.

CWPRS supports this national framework by providing institutionally integrated, SOP-aligned technical solutions to dam owners.

**"India's dam safety framework brings together national and state institutions, dam owners and technical expertise under a unified statutory system."**

## SOP Table

SOP No.	NDSA CDSE Requirement	CWPRS Technical Support
1	Review of previous inspection reports	Review of historical inspections, safety records, O&M practices and existing safety plans
2	Review of Inflow Design Flood (IDF) & spillway adequacy	Review of IDF, spillway capacity, reservoir routing, ownstream flood conveyance and extreme flood scenarios
3	Seismic safety assessment	Seismic performance review and seismic safety evaluation, including site-specific seismic design parameter studies
4	Review of available freeboard	Assessment of freeboard considering updated floods, settlement, wind and wave effects
5	Review of design data	Review of design assumptions, material properties, loads, tailwater conditions and foundation treatment
6	Review of construction data	Review of construction records, as-built drawings, geological conditions and abutment stability
7	Review of operational practices	Assessment of reservoir operation, rule curves, sedimentation, gate operation and downstream conditions
8	Review of safety plans	Review of dam safety plans, EAPs, dam break studies, Dam Instrumentation, Seismic Instrumentation and early warning systems
9	Assessment of hydraulic conditions	Evaluation of seepage, drainage performance, uplift pressures and internal hydraulic safety
10	Evaluation of structural safety	Structural safety assessment of dam and appurtenant structures under static and dynamic conditions
11	Evaluation of maintenance & inspections	Review of rehabilitation works, inspection compliance and overall dam condition
12	Evaluation of hydro-mechanical works	Assessment of gates, hoisting systems, seals, corrosion protection and ageing of HM components
13	Evaluation of other hazard conditions	Assessment of landslides, GLOF risks, downstream scour and other site-specific hazards

# Comprehensive Dam Safety Evaluation (CDSE)

Comprehensive Dam Safety Evaluation (CDSE) is a structured, multidisciplinary assessment mandated by the National Dam Safety Authority (NDSA) to evaluate the overall safety and performance of specified dams. CDSE integrates key technical domains including hydrology, hydraulics, structural and geotechnical engineering, seismic safety, reservoir operation, hydro-mechanical systems, instrumentation and emergency preparedness, into a single, coherent evaluation framework.

The objective of CDSE is to identify potential safety concerns, assess performance under existing and evolving loading conditions and support informed decision-making for operation, maintenance and rehabilitation of dams in accordance with the Dam Safety Act, 2021.



## CWPRS Support for CDSE - SOP - wise Coverage (Aligned with NDSA SOPs)

CWPRS supports dam owners in undertaking Comprehensive Dam Safety Evaluation in full alignment with the NDSA Standard Operating Procedures (September 2024) through an integrated, single-window institutional approach. CWPRS provides coordinated, multidisciplinary technical support for planning, execution and consolidation of all SOP-mandated studies, enabling delivery of consolidated, SOP-aligned outputs to dam owners.

The SOP-wise coverage presented above highlights the scope of CDSE activities undertaken by CWPRS across all thirteen mandatory components prescribed by NDSA, ensuring technical consistency, multidisciplinary integration and clarity of deliverables.

**“CWPRS provides comprehensive, integrated and single-window technical support covering all thirteen mandatory components of Comprehensive Dam Safety Evaluation (CDSE) as prescribed by the NDSA SOP (September 2024).”**

# What CWPRS offers - Integrated Multidisciplinary Expertise

Established in 1916 under the Ministry of Jal Shakti, CWPRS is India's premier national hydraulic research institution, with over a century of contributions to the water and power sector. CWPRS has supported the planning, safety assessment and rehabilitation of major water infrastructure projects in India and neighbouring countries through research-driven engineering services. CWPRS scientists also regularly contribute expert inputs through Dam Safety Review Panels.

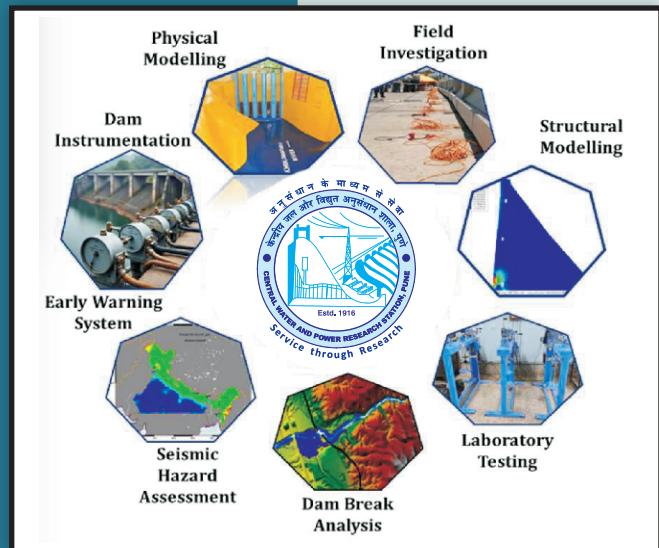
In the domain of dam safety, CWPRS provides end-to-end technical support for dam health monitoring and Comprehensive Dam Safety Evaluation (CDSE), aligned with NDSA SOPs and statutory requirements under the Dam Safety Act, 2021.

## What this means for Dam Owners

- A single institutional partner for CDSE studies
- Integrated, multidisciplinary assessments under one roof
- SOP-aligned technical outputs consistent with national guidelines
- Actionable recommendations for safety enhancement and rehabilitation
- Single-point technical coordination, without fragmentation across agencies

Comprehensive Dam Safety Evaluation requires coordinated expertise across multiple engineering and scientific domains. At CWPRS, CDSE is supported through an integrated institutional framework, drawing upon following specialised engineering and scientific divisions.

This integrated capability enables CWPRS to address all components of dam health monitoring in a technically robust, science-based and project-specific manner.



**"While CWPRS provides the multidisciplinary expertise required for dam health assessment, the Dam Rehabilitation Centre institutionalises this capability into a single-window delivery mechanism for dam owners."**

# Engineering Seismology Division

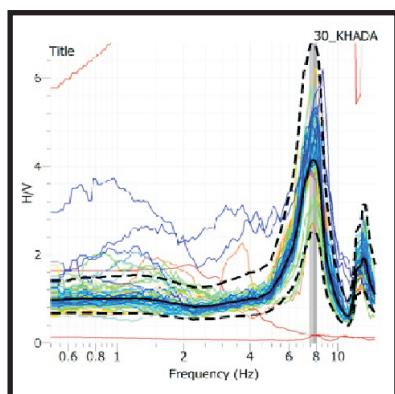
Provides seismic safety inputs essential for assessing dam performance under earthquake loading and reservoir-induced seismicity.

## Key Contributions

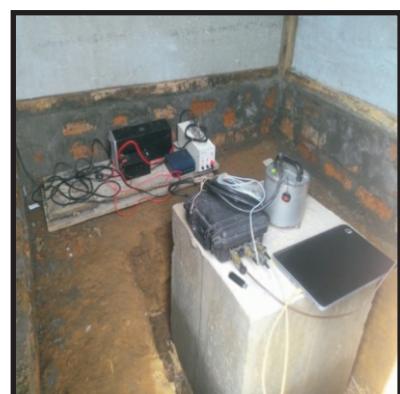
- Seismic hazard assessment and site specific seismic design parameter studies.
- Strong motion and micro-earthquake monitoring
- Reservoir Induced Seismicity (RIS) assessment
- Microtremor and ambient noise studies for site response
- Microearthquake Studies for Nuclear Power and River Valley Projects
- Seismic Instrumentation for Dams



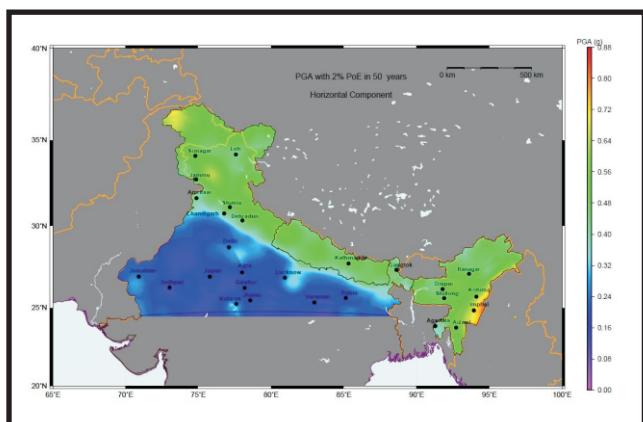
Seismological network  
Kuri Gongri Project, Bhutan



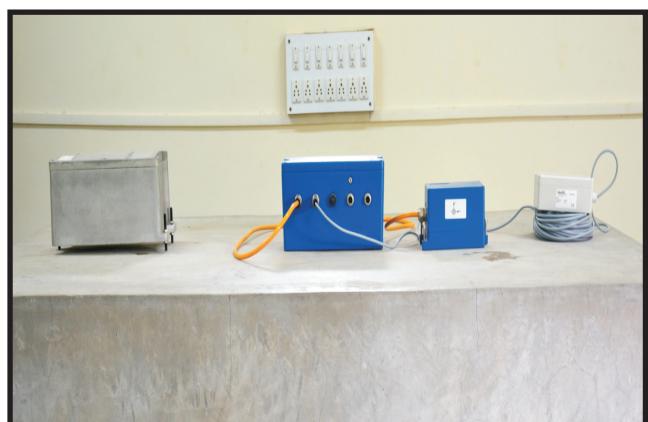
Horizontal to Vertical Spectral  
Ratio (HVSZ) for finding fundamental  
frequency



Seismological equipment installed  
at Mamit observatory,  
Tlawng Project, Mizoram



Hazard assessment of North and North East  
India - Peak Ground Acceleration (PGA) 2% PoE in 50 Years



Seismological observatory  
at CWPRS, Pune

# Geophysics Division

Supports subsurface investigations critical for understanding foundation conditions and internal anomalies affecting dam safety.

## Key Contributions

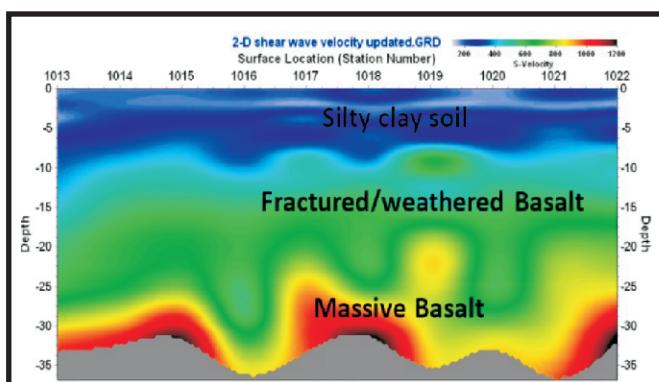
- Subsurface mapping and site characterisation
- Seepage delineation and anomaly detection
- Foundation & Geological Investigations for dams



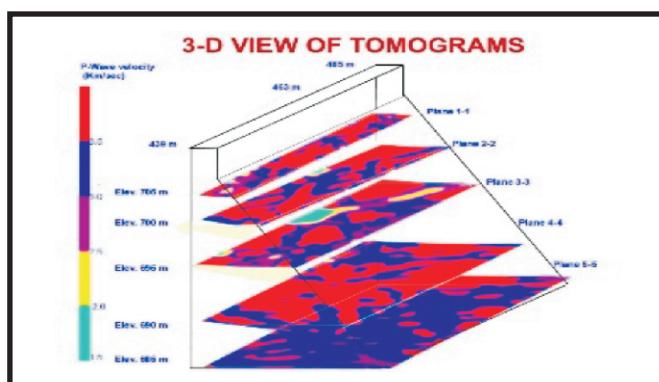
Seismograph



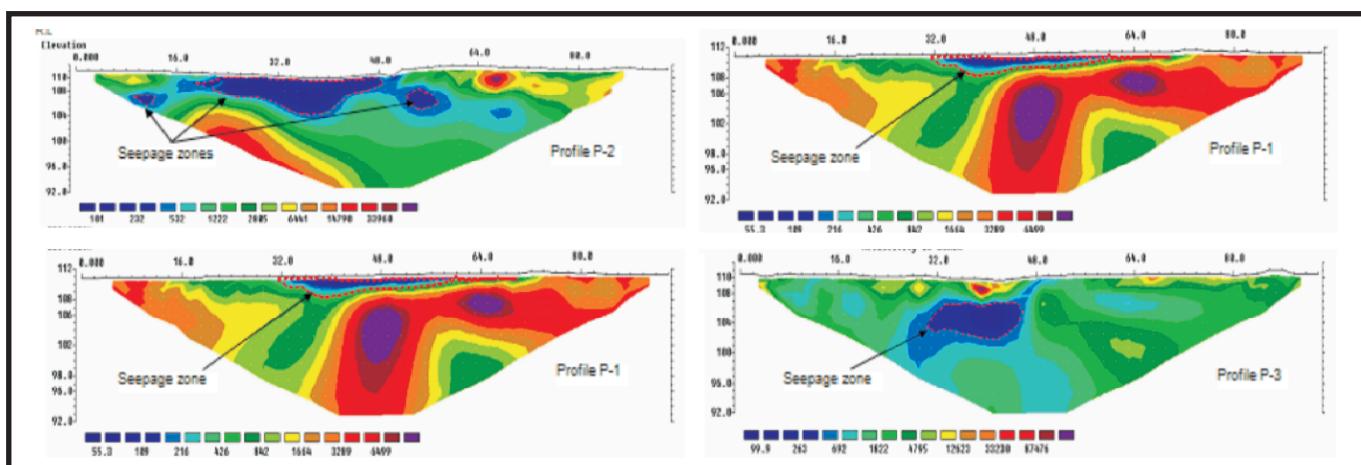
Electrical resistivity imaging setup



2-D Shear wave velocity section



3-D view of tomogram



Electrical resistivity imaging section after modeling

# Vibration Technology Division

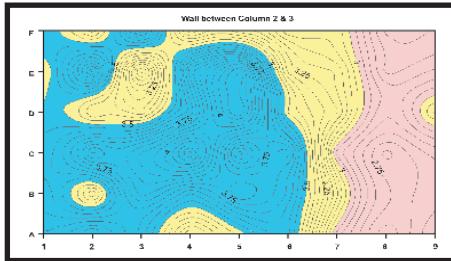
Supports non-destructive assessment of structural and mechanical behaviour of dams and appurtenant structures.

## Key Contributions

- Vibration monitoring of hydraulic structures
- Non-destructive testing (NDT) for condition assessment
- Support to rehabilitation planning and safety assurance



NDT study Ujjani Left bank canal, Maharashtra



Output of NDT study at Rengali HEP, Odisha



Rebound hammer test at Bhatghar HEP, Maharashtra



Underwater blasting operations at JNPT, Mumbai



Sonic wave transmission testing at Khandala dam, Maharashtra



Trunnion beam scanning at Baglihar Dam, J&K

# Concrete Technology Division

Supports assessment and rehabilitation of concrete dams and hydraulic structures.

## Key Contributions

- Condition assessment of distressed concrete structures
- Material testing and durability evaluation
- Repair, rehabilitation and seepage control solutions



500T automatic CTM



Koyna dam strengthening



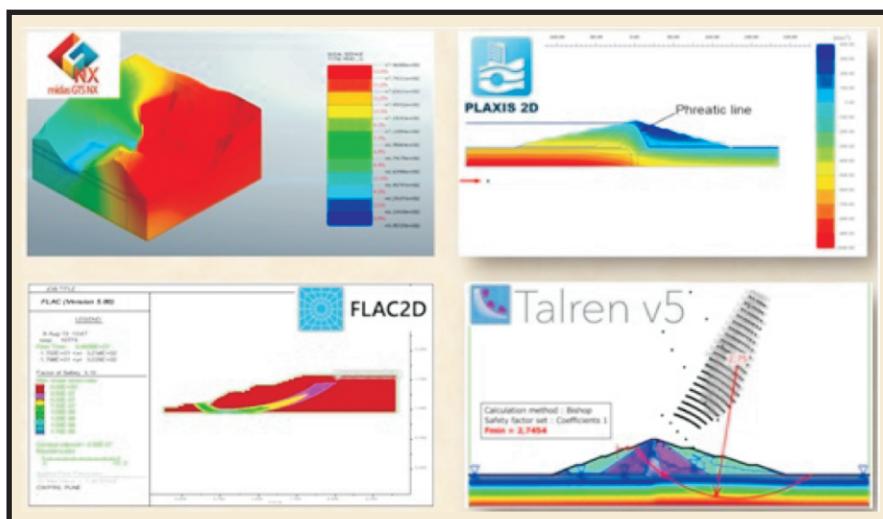
Cementitious grout mixer and pump

# Geotechnical Engineering Division

Addresses foundation, Embankment and slope stability aspects critical to long term dam safety.

## Key contributions:

- Static and seismic stability of earthen, rockfill, tailings dams, and ash dykes
- Seepage studies for earthen/ tailings dams, ash dykes and barrages
- Evaluation of liquefaction potential of soils
- Stability of river/ canal embankments, natural hill slopes, and rim stability of reservoirs
- Seepage and stress-strain analysis of rock mass in tunnels, underground caverns, and powerhouses
- Guidance for geotechnical field investigations and determination of soil/ rock properties
- Confirmatory laboratory testing for soil, rock and geo-textile samples



Modeling studies



Cyclic simple shear equipment



Geotextile tensile testing



Full compression testing machine with Tri axial set up



Flat jack test in masonry dam



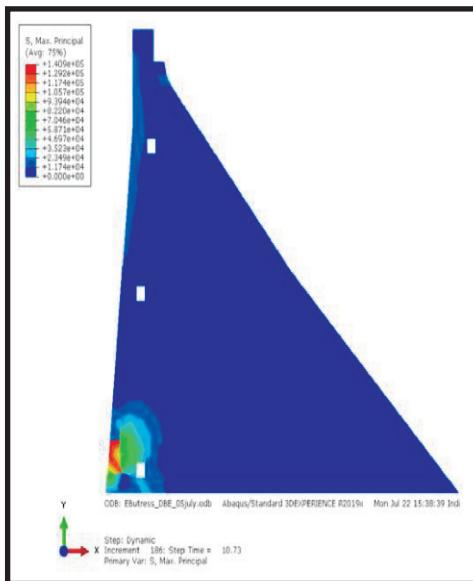
Static triaxial equipment

# Structural Modeling and Analysis Division

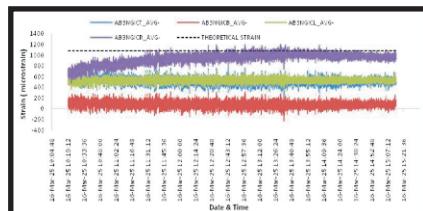
Provides advanced structural safety evaluation of dams and appurtenant structures.

## Key Contributions

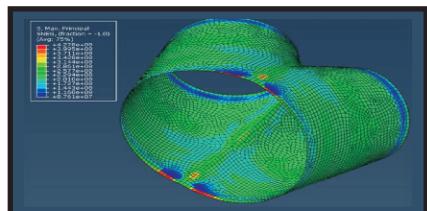
- Static and dynamic structural analysis using FEM
- Structural health assessment of dams and powerhouses
- Evaluation of structural performance of ageing structures



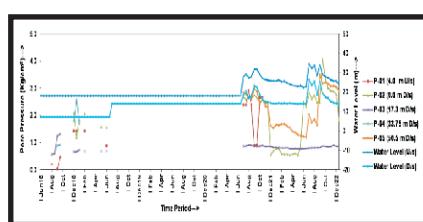
Static & dynamic structural FEM analysis of dam structure



Structural health assessment of dams and powerhouses through strain measurement



Static & dynamic structural FEM analysis of penstocks



Structural health assessment of dams and powerhouses through pore pressure measurement



32 channel data acquisition system with live monitoring

# Isotope Hydrology Division

Provides specialised seepage and subsurface connectivity studies using advanced tracer and borehole techniques.

## Key Contributions

- Seepage source and pathway identification
- Reservoir-foundation interaction studies
- Borehole logging and tracer-based investigations



Borehole logging studies for geo-technical investigations



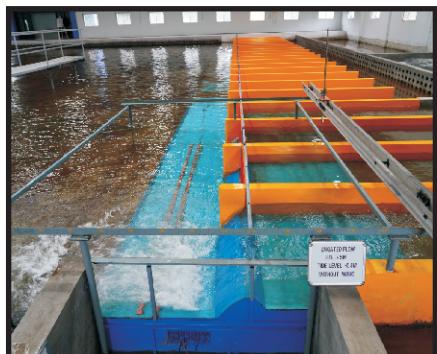
Coupling radioactive sources for nuclear density logging studies

## Spillways and Energy Dissipators Division / Control Structures & Water Conductor Systems Division

Supports hydraulic and sedimentation studies influencing dam safety and operational efficiency.

### Key Contributions

- Spillway and energy dissipation studies
- Sedimentation and desilting assessments
- Evaluation of gates, tunnels and water conductor systems
- Physical and numerical hydraulic modelling



Model of Kalpasar project, Gujarat



Desilting basin model



Model of Polavaram dam



Model of Kwar HE project, J&K



Model of Indira Sagar dam



Model of Mangdechhu dam spillway



Kwar project foundation stone laying on 24.04.2022



Mangdechhu HE project, Bhutan inauguration on 17.08.2019

## Hydraulics and Prototype Testing Division

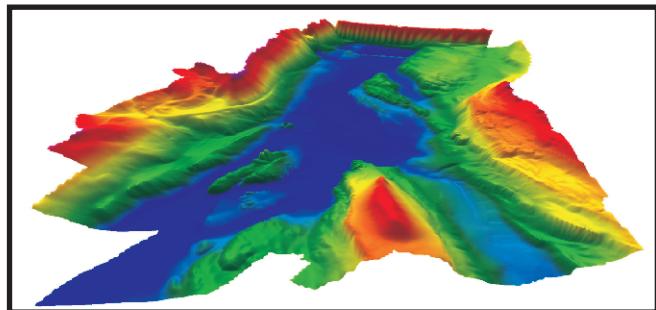
Supports reservoir sedimentation and operational safety studies.

### Key Contributions

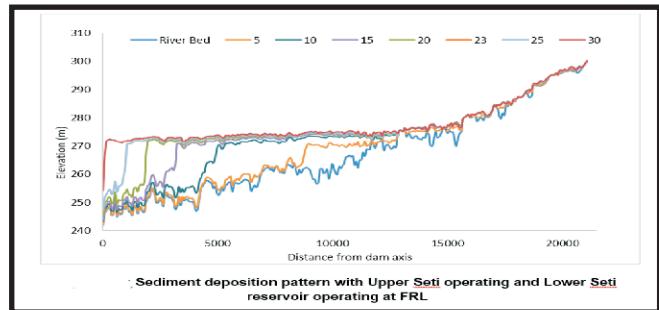
- Reservoir sedimentation assessment and bathymetric surveys
- Sediment management through flushing and sluicing
- Gate regulation studies for safe reservoir operation



Reservoir flushing operation at Mangdechhu Hydro-Electric Project, Bhutan



Digital Elevation Model (DEM) of the Indira Sagar Project, Madhya Pradesh, India



Sediment deposition pattern observed when the Upper Seti project is in operation and the Lower Seti reservoir is operating at Full Reservoir Level (FRL)

## Dam Instrumentation Division

Provides instrumentation-based monitoring essential for continuous dam health assessment.

### Key Contributions

- Review and interpretation of dam instrumentation data
- Monitoring of uplift pressure, displacement and stresses
- Support to early detection of distress in ageing dams



Uplift pressure gauge



Triaxial joint meter



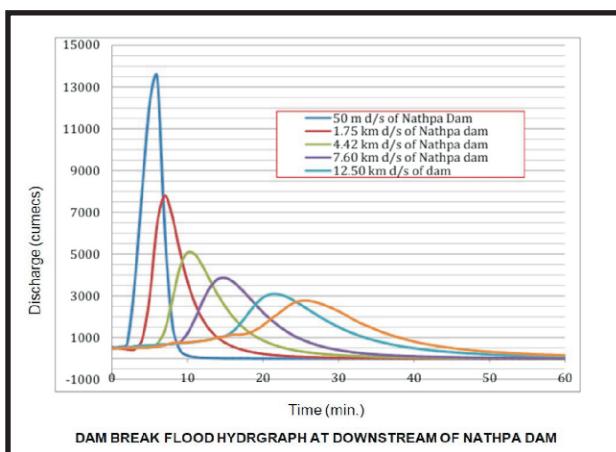
MEMS based tiltmeter

# Disaster Management & Planning Division

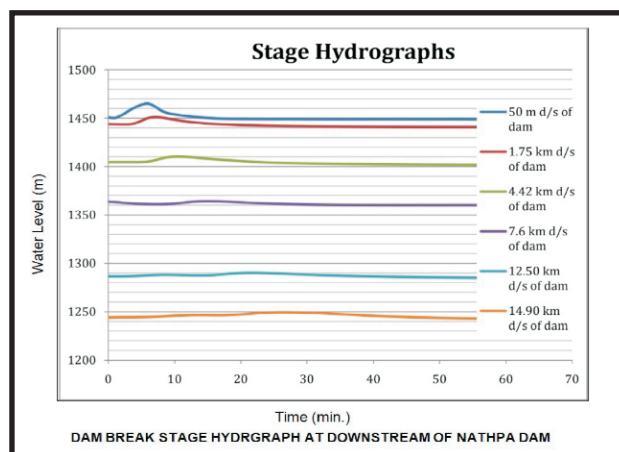
Supports emergency preparedness and downstream risk assessment as mandated under the Dam Safety Act.

## Key Contributions

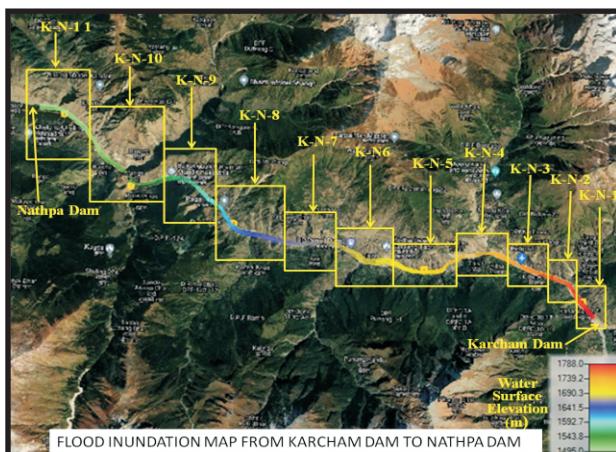
- Dam break analysis and flood routing studies
- Emergency Action Plan (EAP) preparation
- Inundation mapping and flood risk assessment



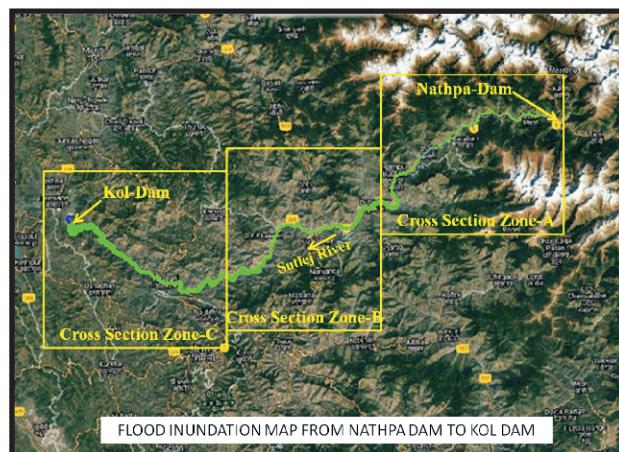
Dam break flood hydrograph at downstream of Nathpa dam



Dam break stage hydrograph at downstream of Nathpa dam



Flood inundation map from Karcham dam to Nathpa dam



Flood inundation map from Nathpa dam to Kol dam

This integrated capability enables CWPRS to address all components of dam health monitoring in a technically robust, science-based and project-specific manner.

**"While CWPRS provides the multidisciplinary expertise required for dam health assessment, the Dam Rehabilitation Centre institutionalises this capability into a single-window delivery mechanism for dam owners."**

## Dam Rehabilitation Center (DRC): Single-Window Institutional Mechanism

To translate its multidisciplinary expertise into coherent, coordinated and actionable outcomes, CWPRS has established the Dam Rehabilitation Centre (DRC) as a dedicated institutional platform for dam health monitoring and rehabilitation services.

The DRC functions as the single-window interface for dam owners, serving as the nodal hinge point for all Comprehensive Dam Safety Evaluation and rehabilitation-related studies within CWPRS. Through the DRC, multidisciplinary investigations across CWPRS divisions are planned, coordinated and integrated to ensure full alignment with the NDSA SOPs. The Centre enables seamless integration of field investigations, laboratory testing, physical modelling and numerical analysis, ensuring technical consistency, quality assurance and timely delivery of consolidated outputs. By institutionalising coordination through the DRC, CWPRS ensures that dam owners receive unified, SOP-aligned deliverables without fragmentation of responsibilities across individual disciplines.

**"For dam owners, the DRC provides a single interface and a coordinated technical framework to support dam health monitoring and safety assessment."**



# Engagement Pathway

## How Dam Owners Can Engage CWPRS for CDSE

Dam owners and agencies may engage CWPRS for Comprehensive Dam Safety Evaluation through a structured and transparent process:

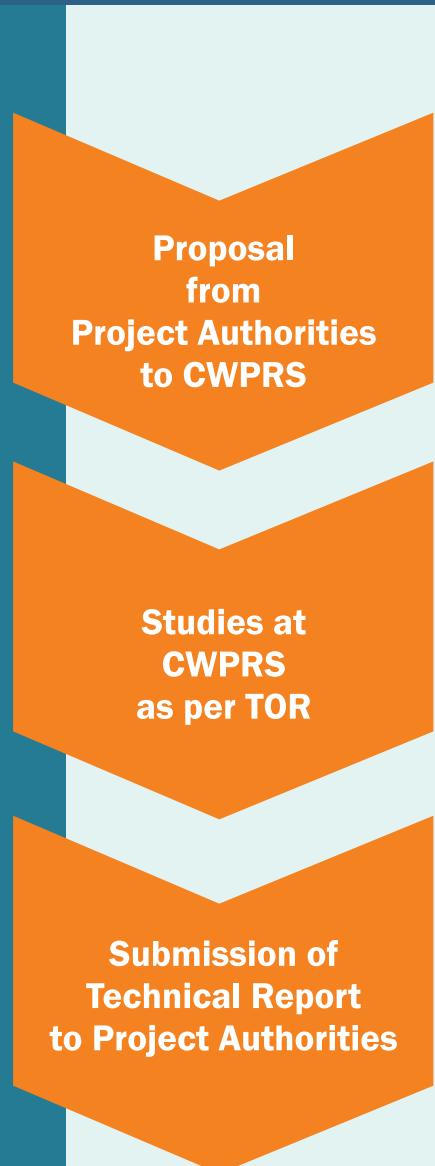
## Engagement Pathway with CWPRS

1. **Initial Request / Reference** by Dam Owner or SDSO
2. **Scoping and Alignment** with NDSA SOP requirements
3. **Integrated CDSE Studies** coordinated by CWPRS
4. **Consolidated Technical Outputs** and recommendations
5. **Support for Rehabilitation & Follow-up Studies**, as required

CWPRS engages with dam owners through a **structured, transparent and technically accountable process**, ensuring clarity of scope, timelines and deliverables.

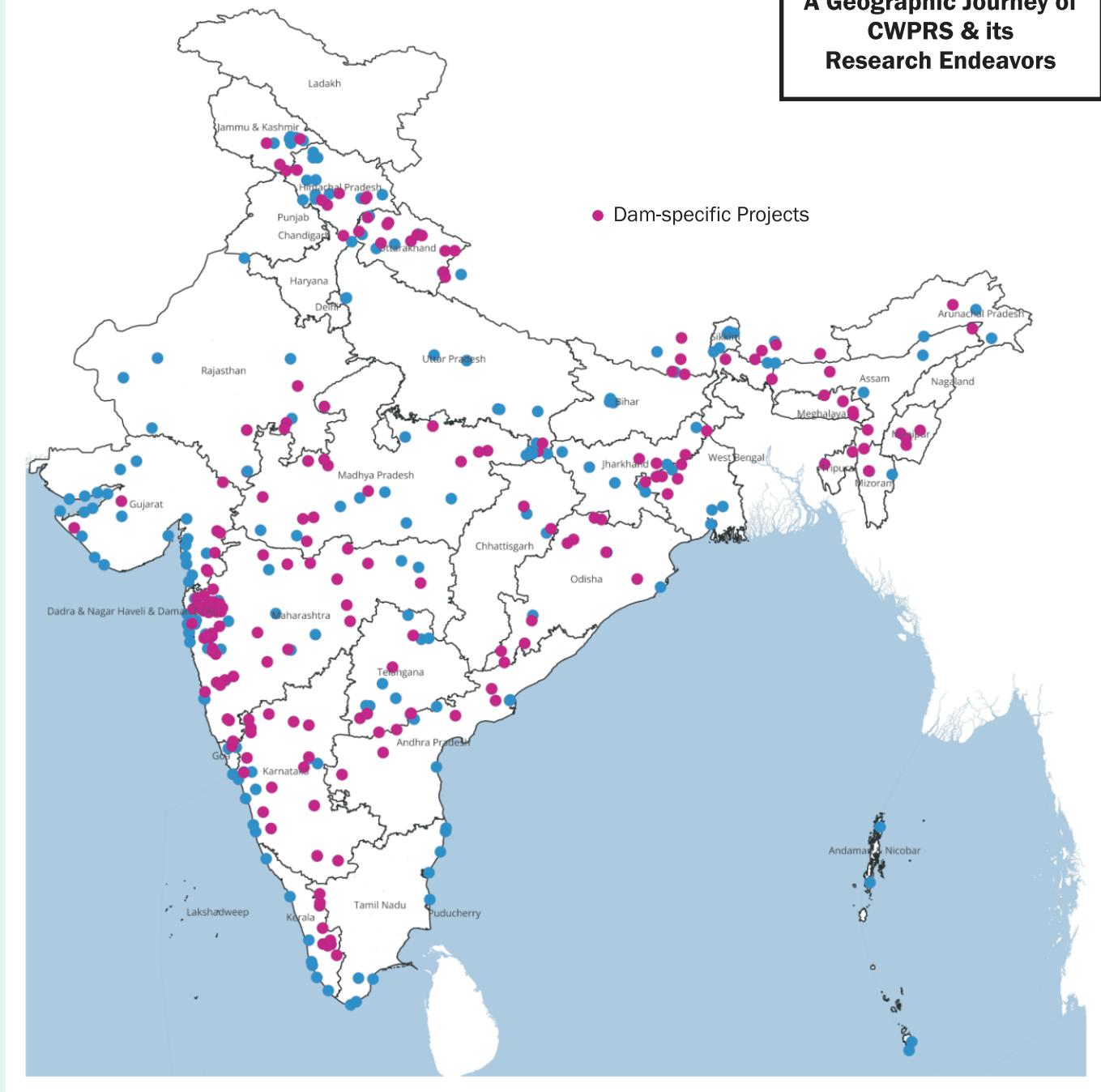
# CWPRS - National Single-Window Technical Support for Dam Health Monitoring

Through its integrated institutional capability, CWPRS supports dam owners in fulfilling their statutory obligations under the Dam Safety Act, 2021 and the NDSA CDSE framework. By combining multidisciplinary expertise with research-driven engineering solutions, CWPRS contributes to strengthening dam safety, resilience and public confidence in water infrastructure.



# CWPRS | Your Single-Window Technical Partner for CDSE

A Geographic Journey of  
CWPRS & its  
Research Endeavors



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