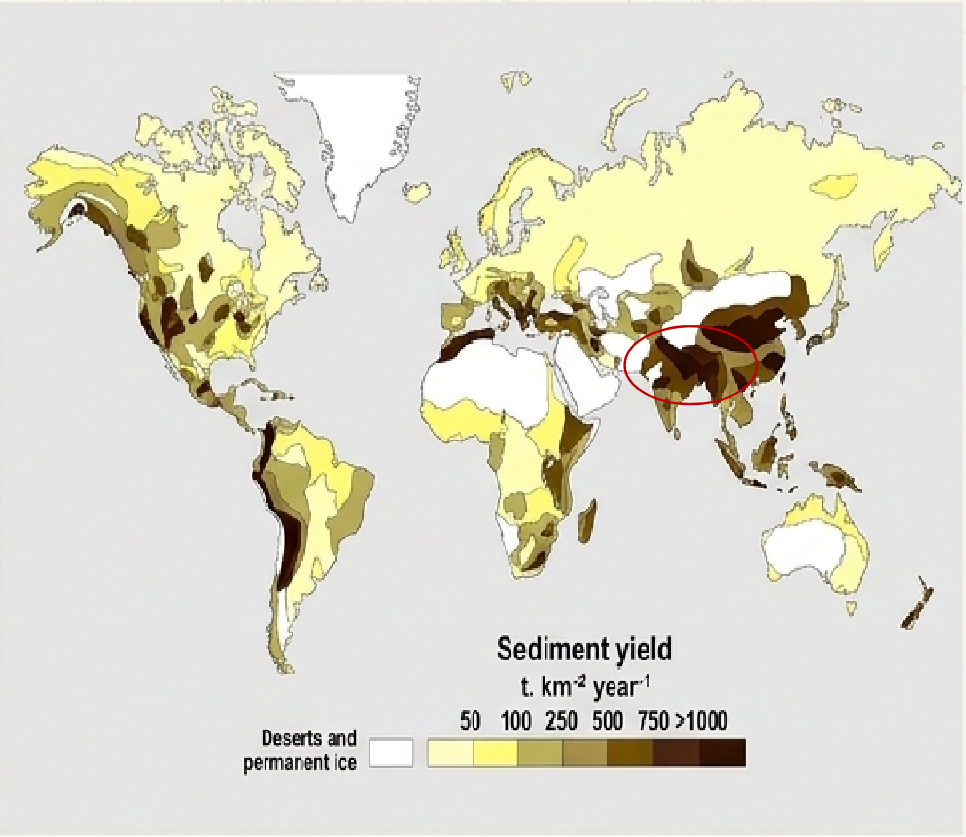
INDIA WATER WEEK 2026

DESILTATION THROUGH SLUICING AND FLUSHING

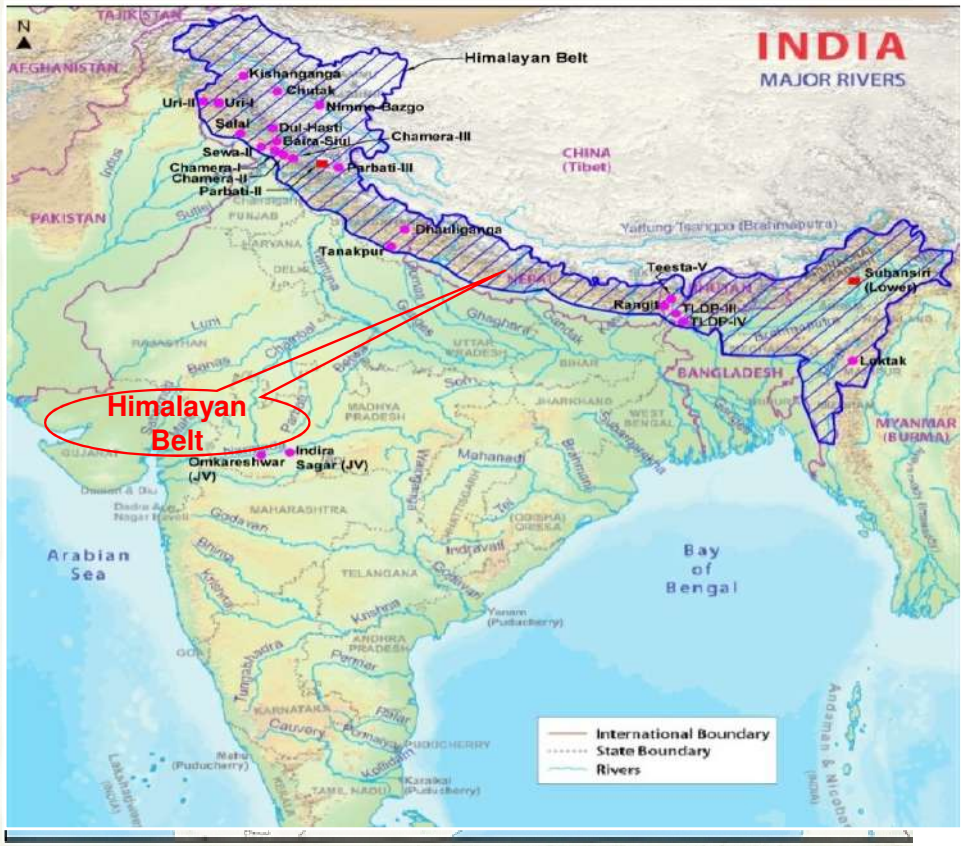
Manjusha Mishra
General Manager (Civil)
NHPC Limited

SEDIMENTATION PROBLEM

THE MACRO THREAT OF SEDIMENTATION



The NHPC Footprint:
8.6 GW Active Operations | 9.5 GW Under Construction

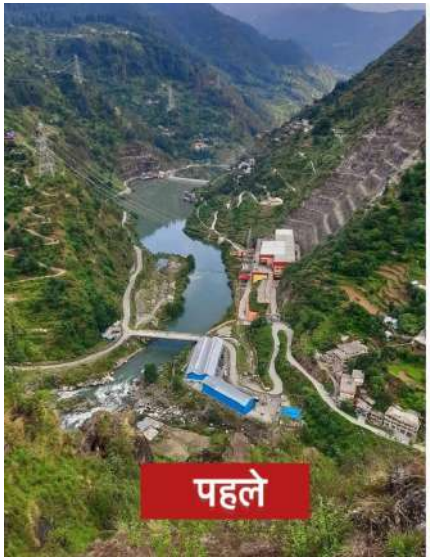


Loss in Live Capacity (CWC Sample) : National Average 0.49% per year, 1.35% in Himalayan Region

SEDIMENTATION PROBLEM

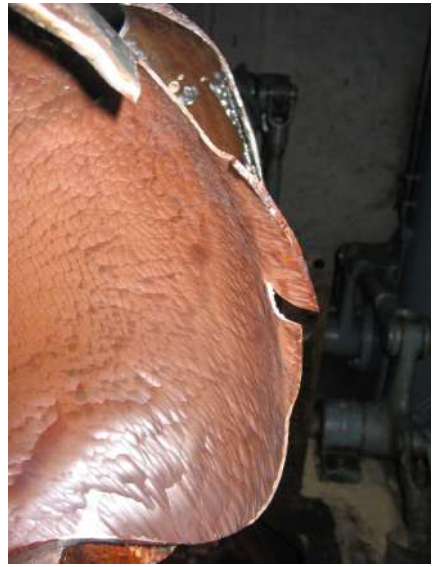


1. Loss of Storage Capacity
2. Increased Flooding due to delta deposits
3. Abrasion and Damage of turbines, spillways, and WCS
4. Reduced Power Generation and peaking availability
5. Operational Difficulties such as blocked outlets, hindering gate operations
6. Decreased Spillway Capacity

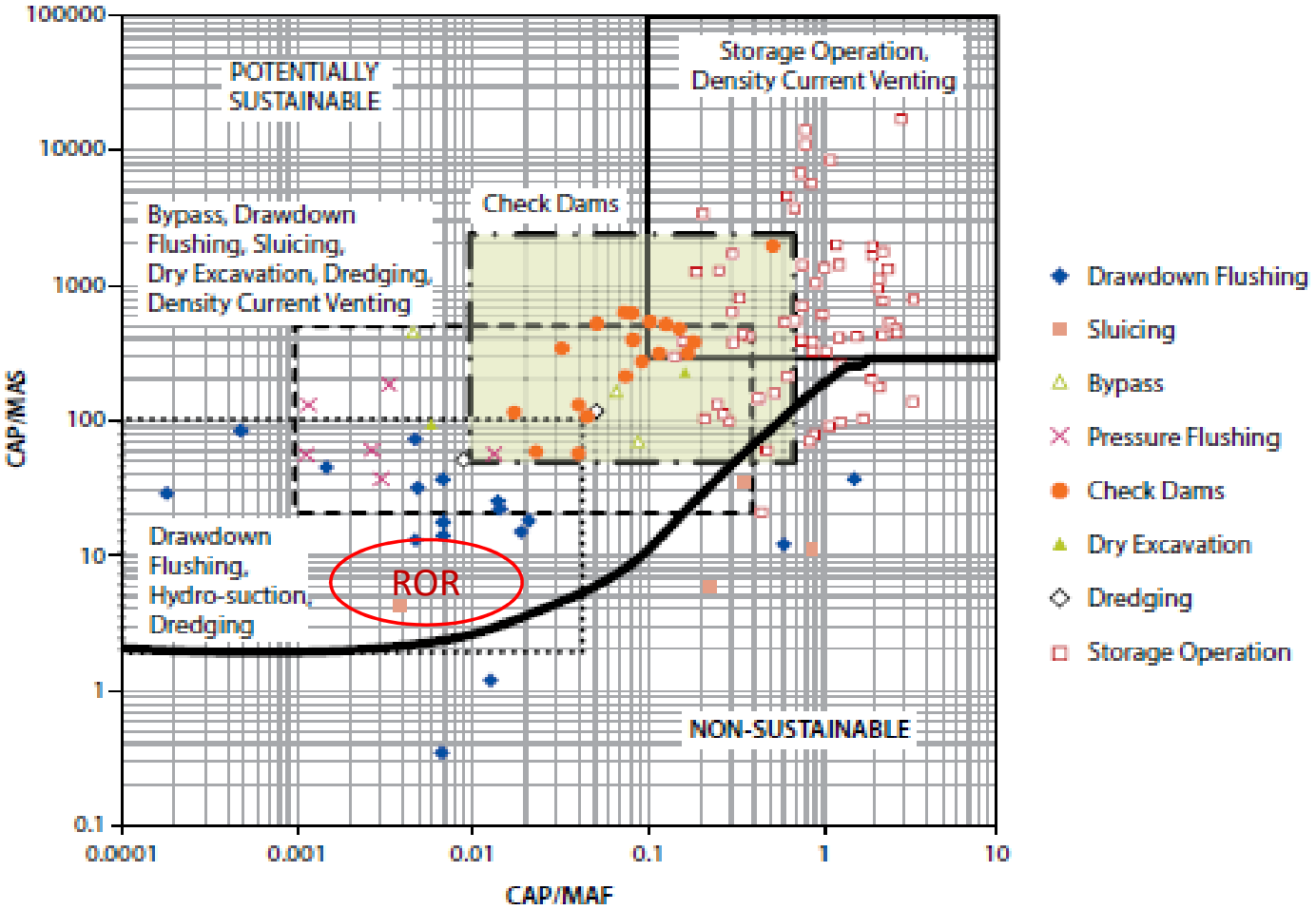






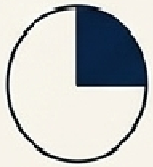
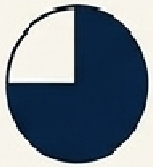
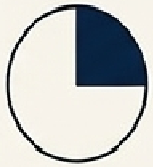
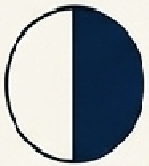
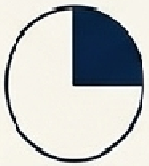


SEDIMENT MANAGEMENT ALTERNATIVES



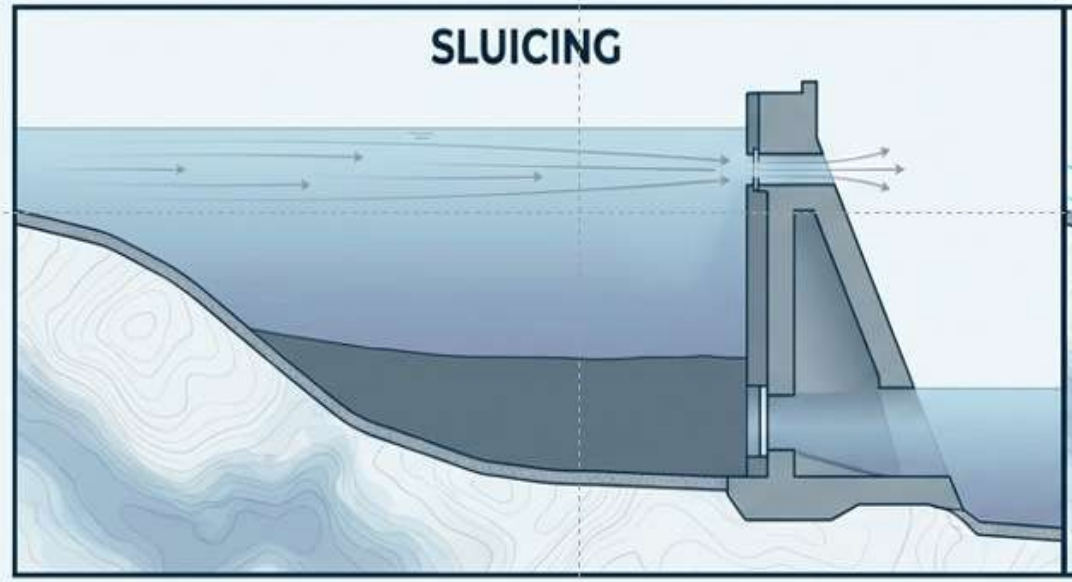
Annandale (2013): "Quenching the Thirst: Sustainable Water Supply and Climate Change", Create Space Independent Publishing Platform, Charleston, SC.

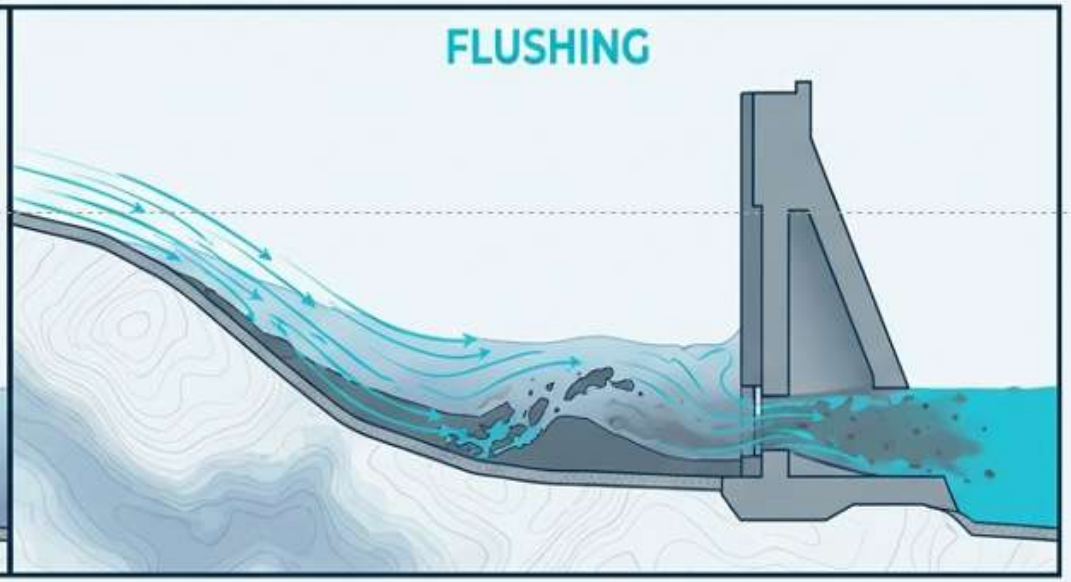
SEDIMENT MANAGEMENT ALTERNATIVES

Technique	Mechanism	Efficacy in Himalayas	Lifecycle Cost
Catchment Management	Trapping sediment upstream.	 Low - Check dams fail	 High
Dredging	Mechanical excavation.	 Low - Space constraints for disposal	 Very High
Sluicing	Bypassing sediment via lower levels.	 Moderate - Temporary generation loss	 Medium
Hydraulic Scour (Flushing)	Emptying reservoir to scour bed.	 Maximum	 Highly Effective

The Non-Negotiable Operational Standard for Himalayan RoR Projects

BENEFITS OF FLUSHING OVER SLUICING



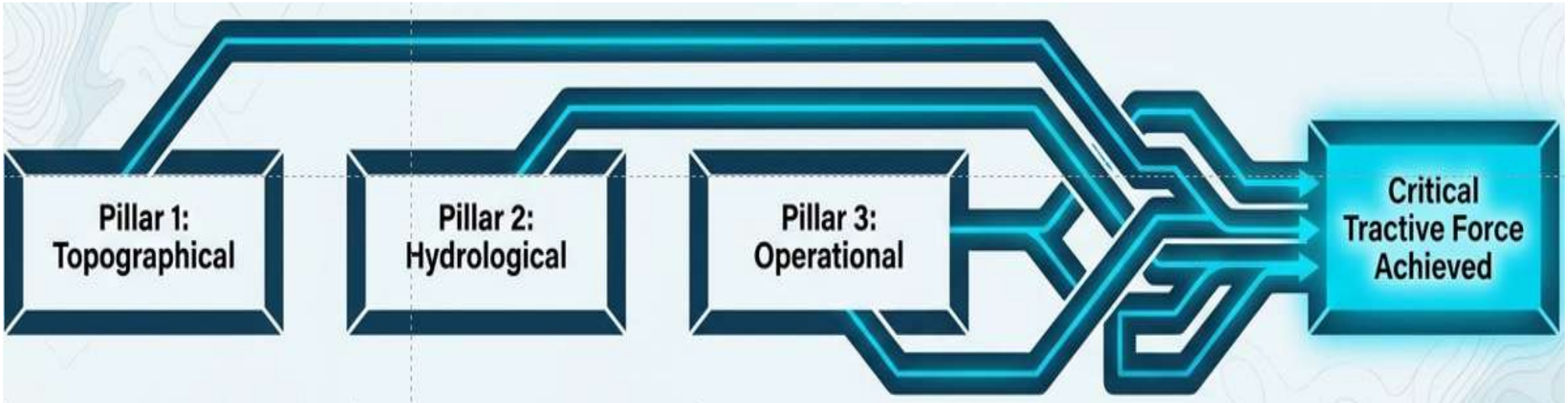


Diagnostic Comparison Matrix

	SLUICING (Status Quo)	FLUSHING (Optimal)
Sediment Evacuation Efficiency	Low (Routes incoming suspended loads only)	High (Actively scours and removes historical bedload deposits)
Water Yield Impact	Minimal (Maintains high head/water levels during operation)	Significant (Requires total or near-total drawdown)
Long-term Capacity Preservation	Stagnant (Prevents worsening but does not recover lost volume)	Restorative (Recovers active storage volume)

Drawdown flushing also helps in clearing the trash collected in front of power intakes -> increases the head for generation.

CONDITION FOR EFFECTIVE SEDIMENT FLUSHING



Steep Channel Gradients

The original river valley must possess a sufficiently steep natural slope to generate high flow velocities once the water is released. Without a steep gradient, the water lacks the gravity-fed momentum to mobilize heavy bedload sediments.

Sufficient Discharge

Adequate natural inflow (typically during specific seasonal flood windows) is required to supply the volume of water needed to physically push the scoured sediment through the reservoir and out of the dam gates without stalling.

Complete Reservoir Drawdown

The reservoir level must be lowered dramatically. This eliminates the pooling effect, forcing the water to revert to a fast-moving, riverine flow state rather than a deep, slow-moving lake state.

Generating the critical tractive force for flushing requires strict alignment across three pillars

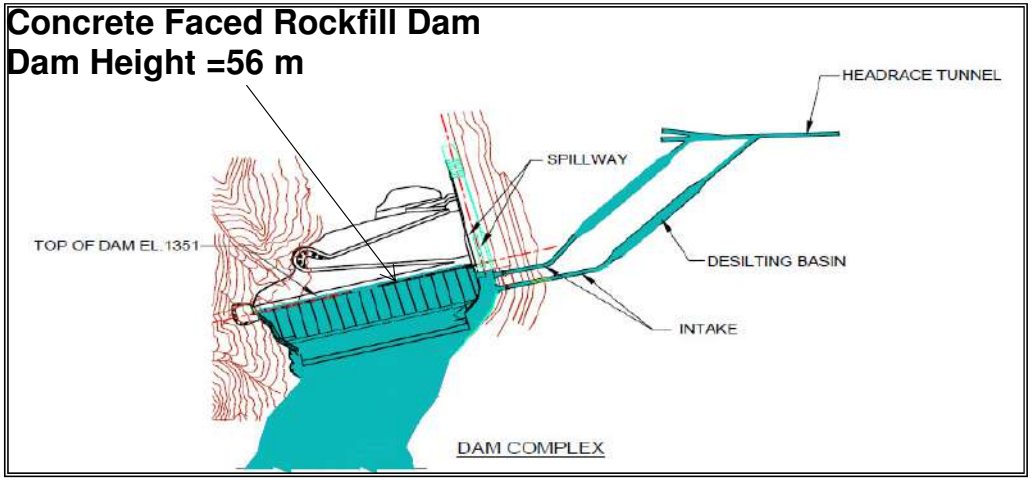
Providing deep large outlets in dam body at a level close to original river bed and lower than intake crest level, helps in effective flushing -> should be planned during design

LESSONS LEARNED
CASE STUDIES

DHAULIGANGA POWER STATION (280 MW)

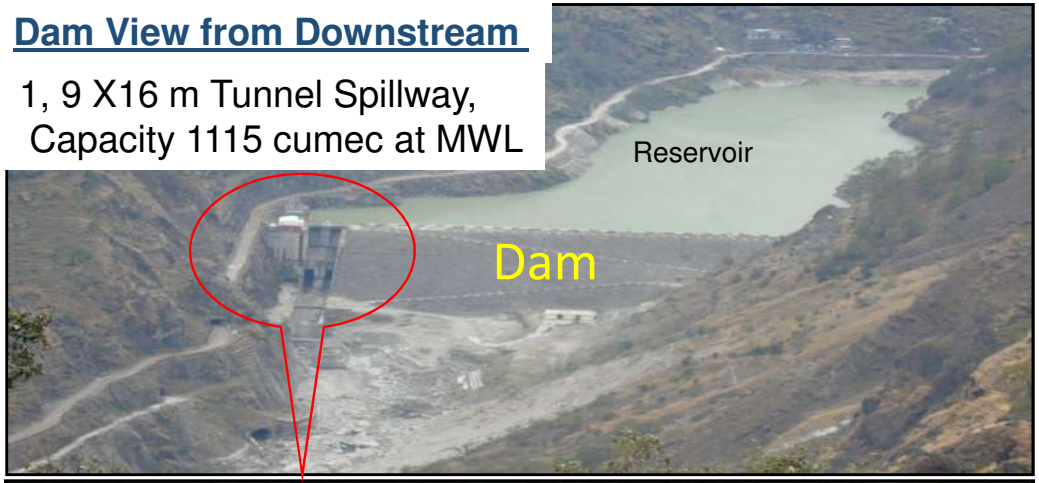
COMMISSIONED IN 2005, IN UTTARAKHAND

Concrete Faced Rockfill Dam
Dam Height =56 m

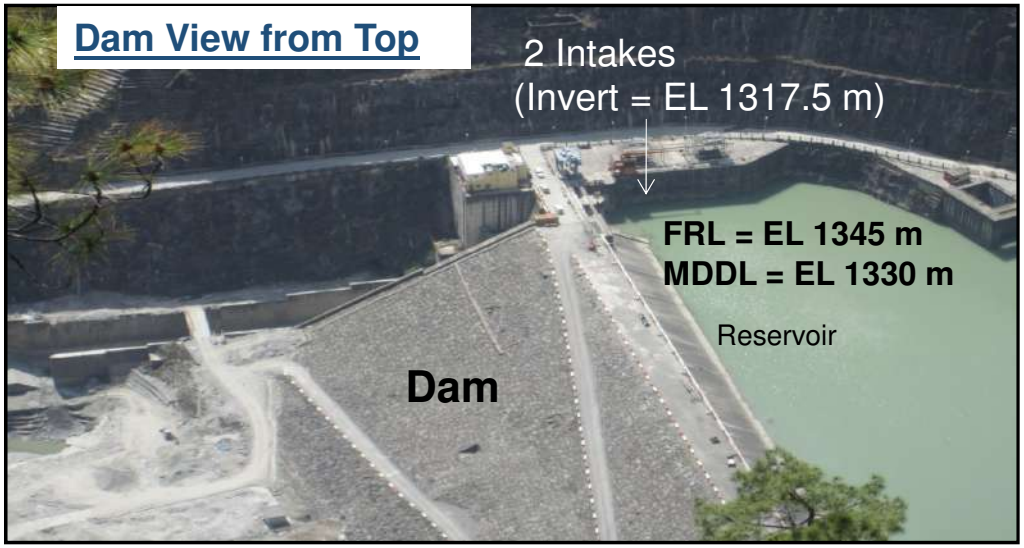


Dam View from Downstream

1, 9 X16 m Tunnel Spillway,
Capacity 1115 cumec at MWL



Dam View from Top



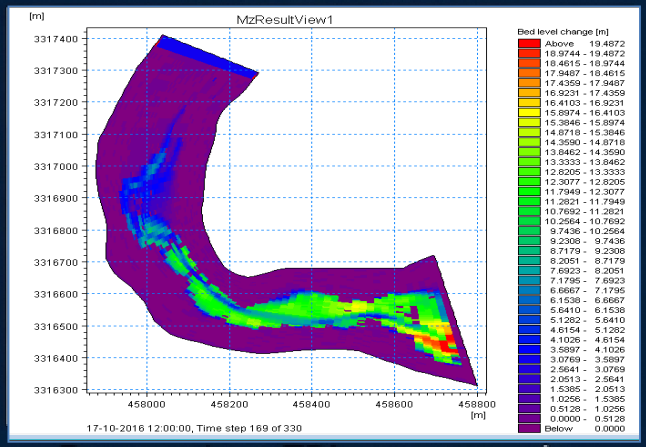
Spillway Section (from d/s)



2 Spillways with radial gates of Size 6mX10m (capacity 2560 cumec at MWL) , Crest Level = EL 1307 m

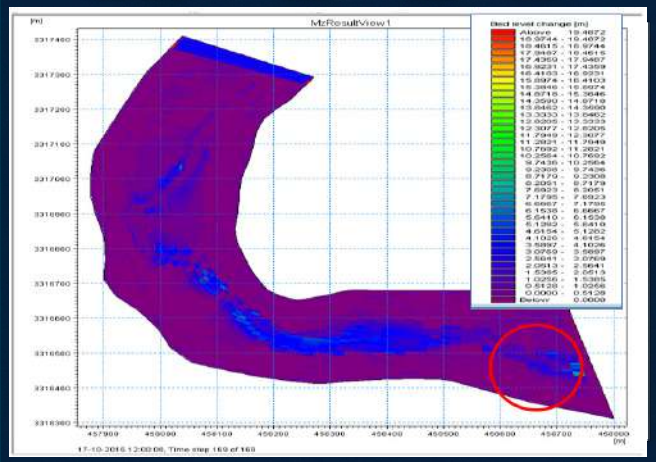
PROVING THE PHYSICS – 2-D MODELLING IN DHAULIGANGA RESERVOIR

Case I: Do Nothing



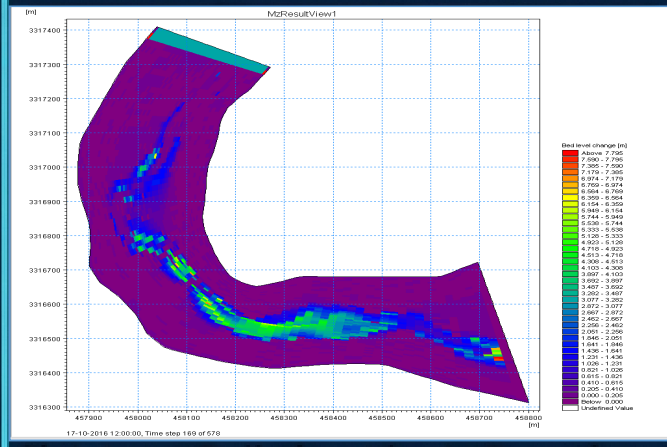
Reservoir at FRL year-round = Catastrophic 20m sediment deposition near spillways.

Case II: Partial Measure

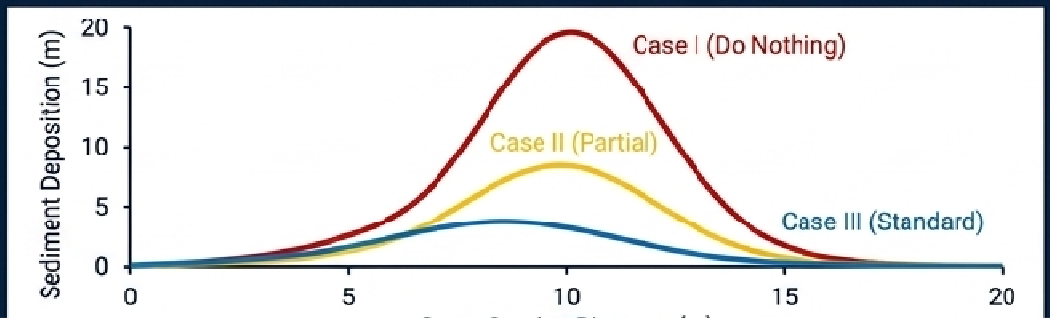


Sluicing only at MDDL = 10-11m deposition.

Case III: The Standard

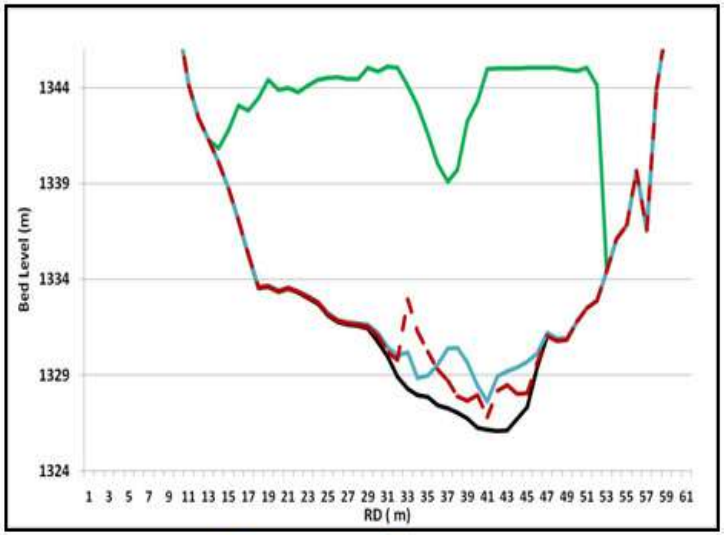


Sluicing + Full algorithmic Drawdown Flushing = Sustainable 5-6m deposition after one monsoon.

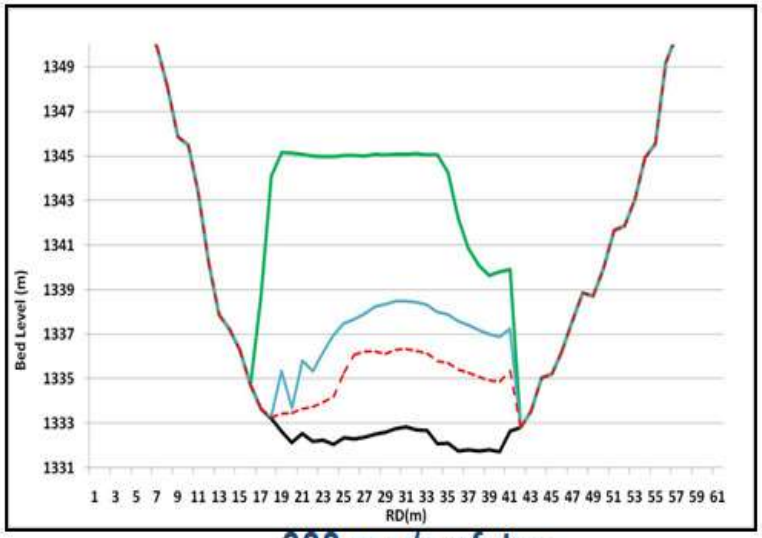


Advanced Mike 21C 2D modeling proves that sluicing alone is insufficient. Integrated drawdown flushing reduces deposition by 70-75%.

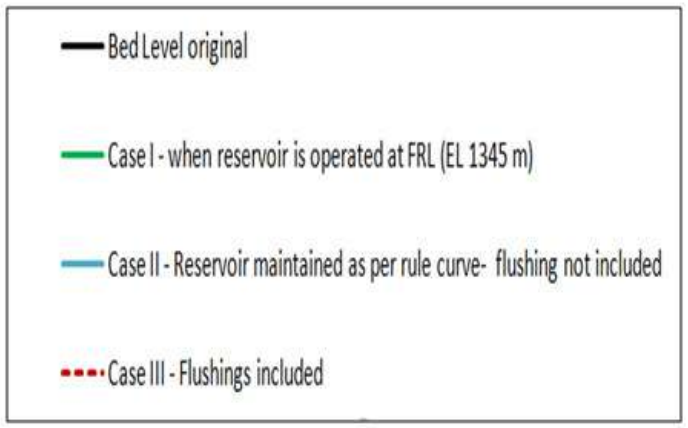
2-D MODEL - USING MIKE 21C

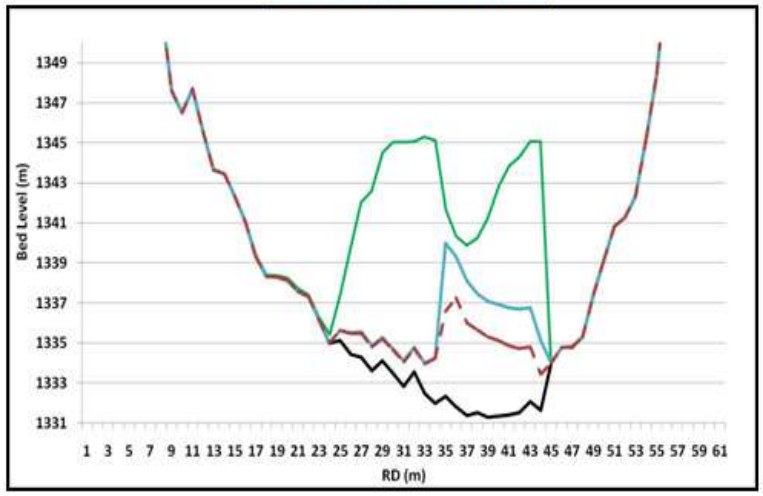


50 m u/s of dam



300 m u/s of dam

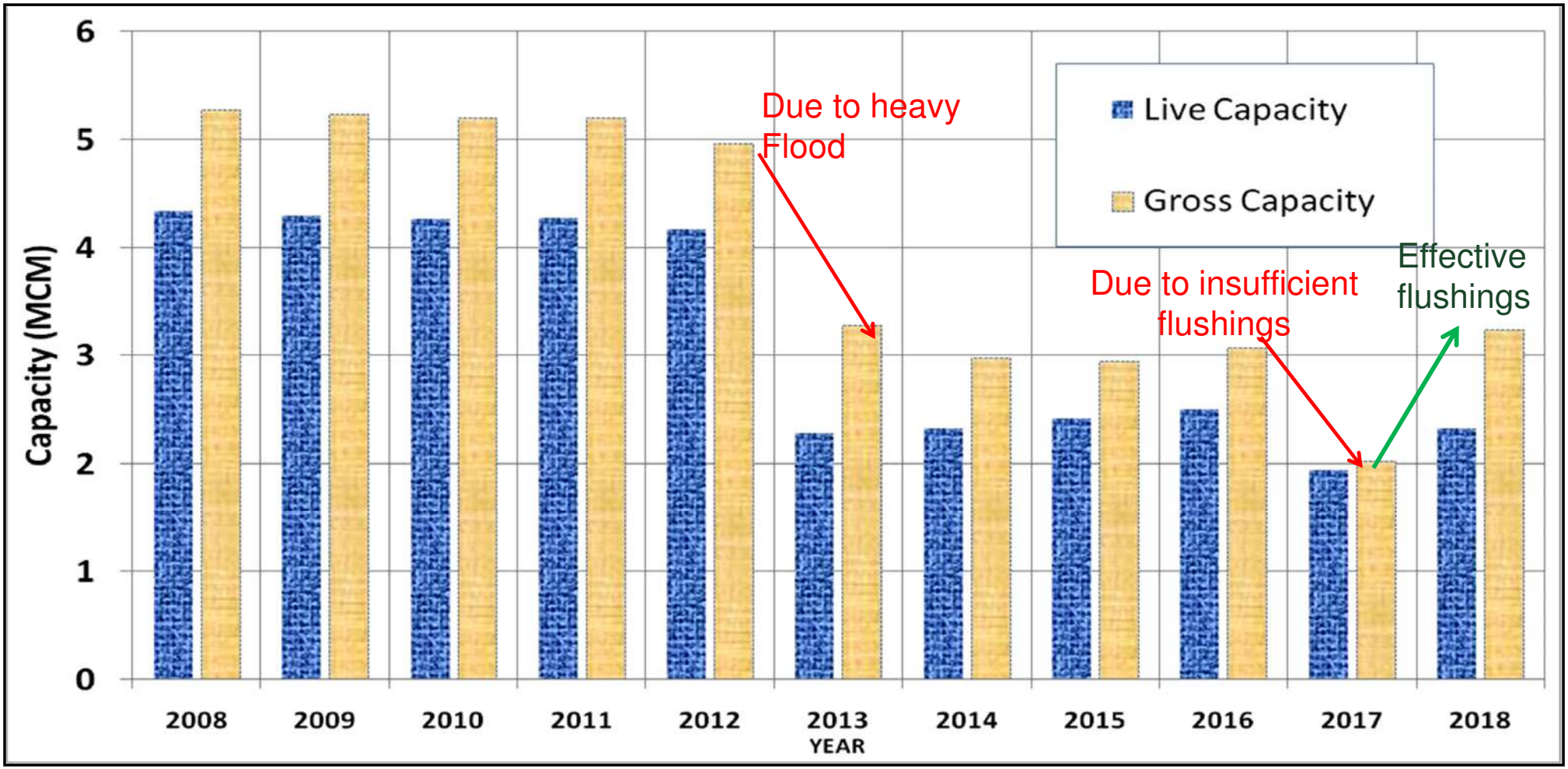




400 m u/s of dam

Sediment deposition in **case I is much higher** which get **reduced in case II** (reservoir at MDDL in monsoon) **and gets further reduced** when flushings are included in case III.

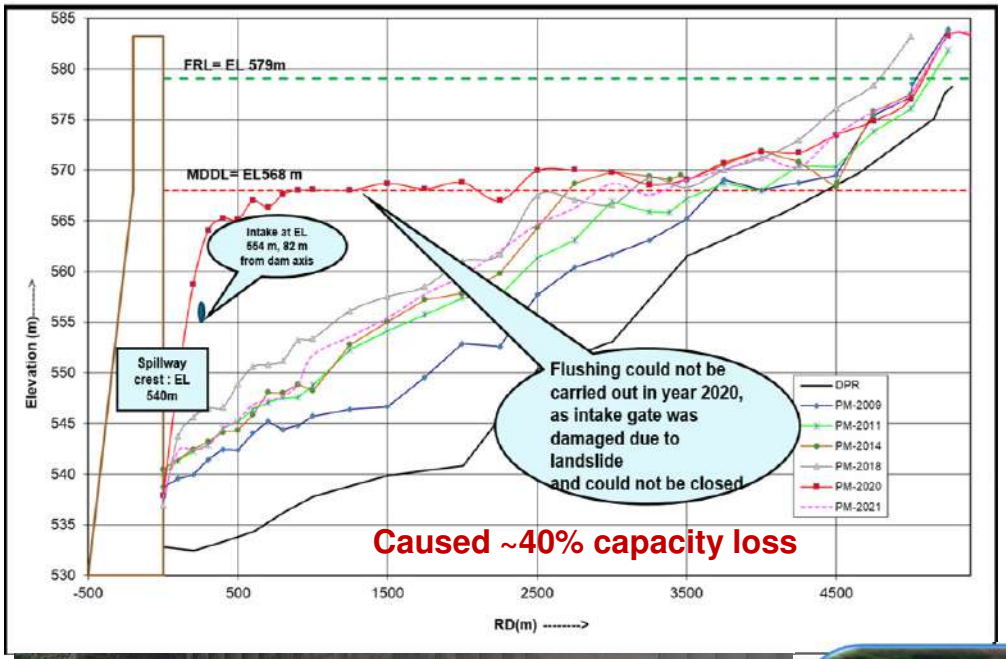
DHAULIGANGA POWER STATION
RESERVOIR CAPACITIES OVER THE YEARS

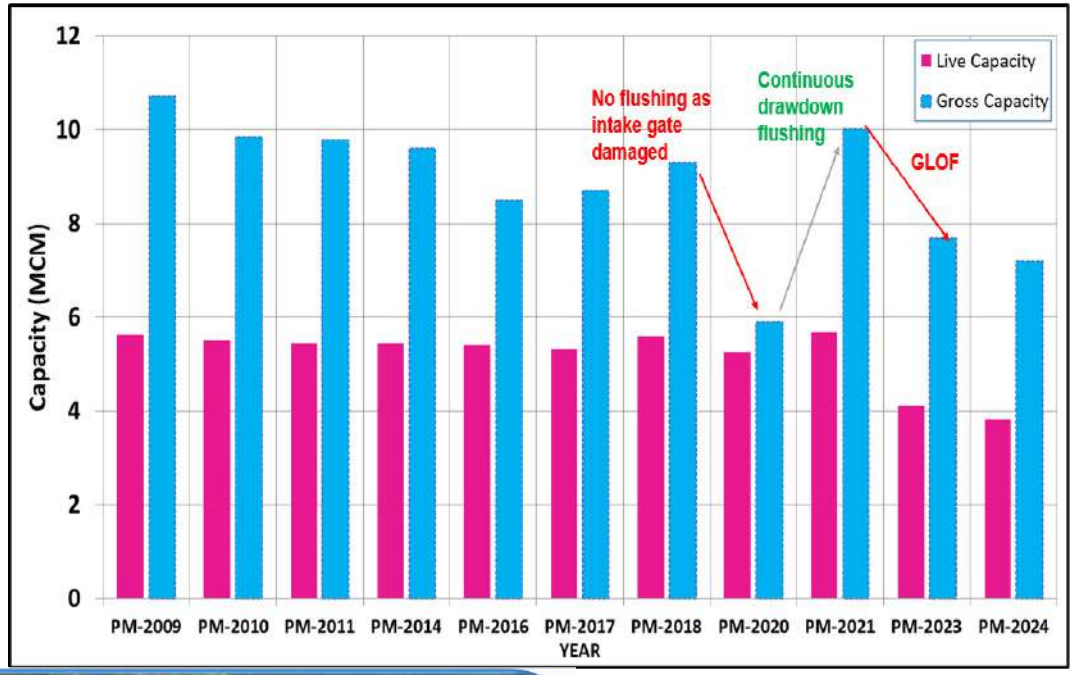


TEESTA-V POWER STATION (510 MW)
COMMISSIONED IN 2008



TEESTA-V POWER STATION
L-SECTION AND RESERVOIR CAPACITIES OVER THE YEARS



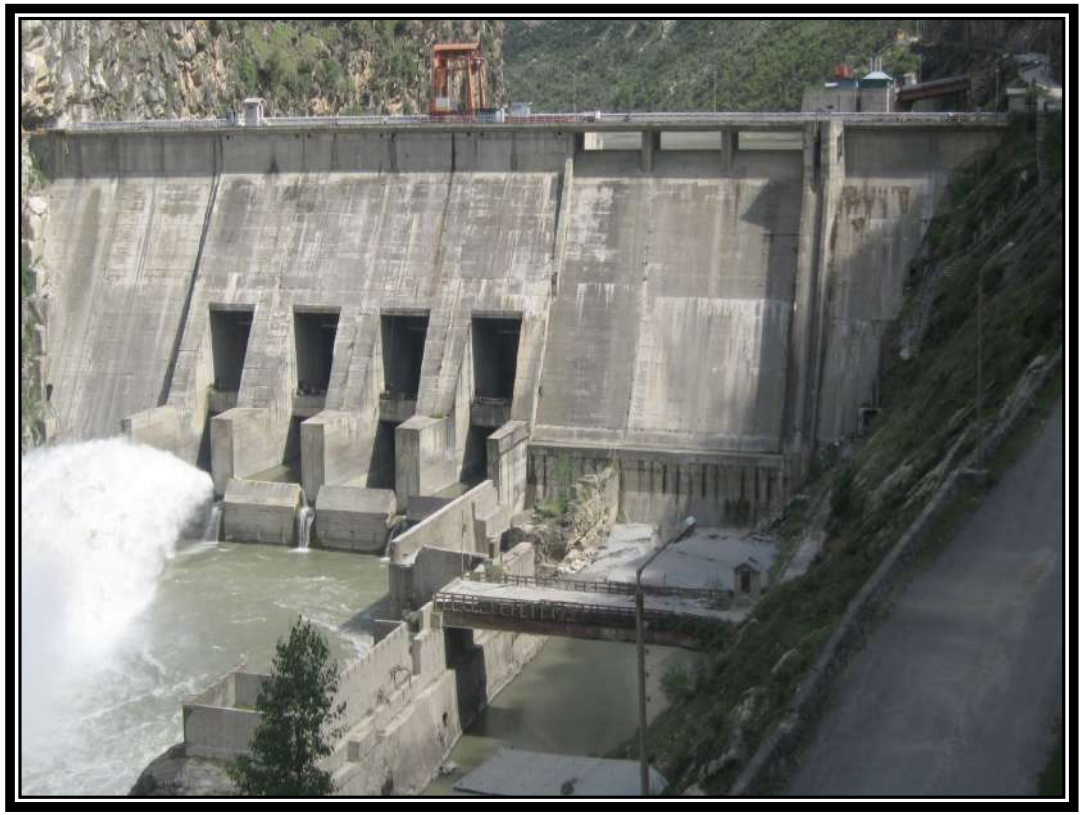



Sediment deposition at Intake (2020)


Flushing in 2021


After GLOF

DULHASTI POWER STATION (690 MW)
COMMISSIONED IN 2007, J&K



FRL 1266.5 m, MDDL 1238.9 M
Average annual sediment load:~15 MCM

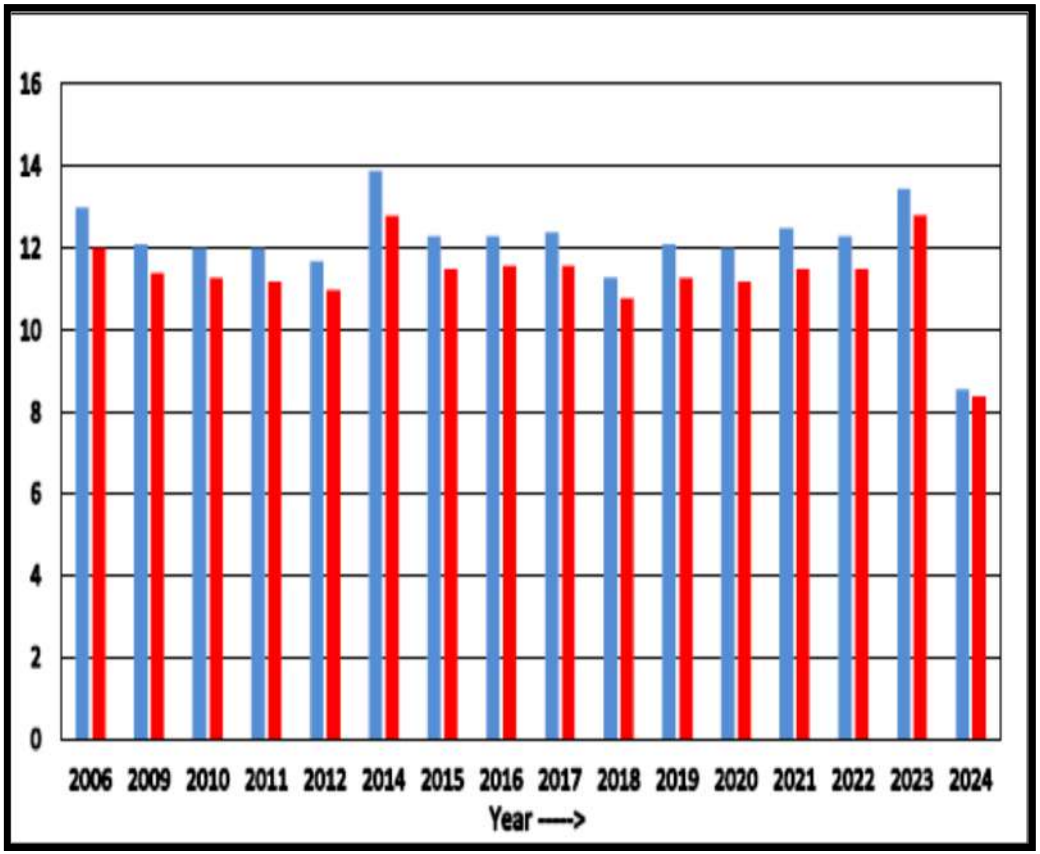
Structural Design for Sediment Control

Low Level Spillway : 4, 9 m × 9.5 m spillway gates located at **EL 1225 m**, to pass the 8000 cumec design flood along with **ungated spillway at FRL with a log chute** is located on the left wing.

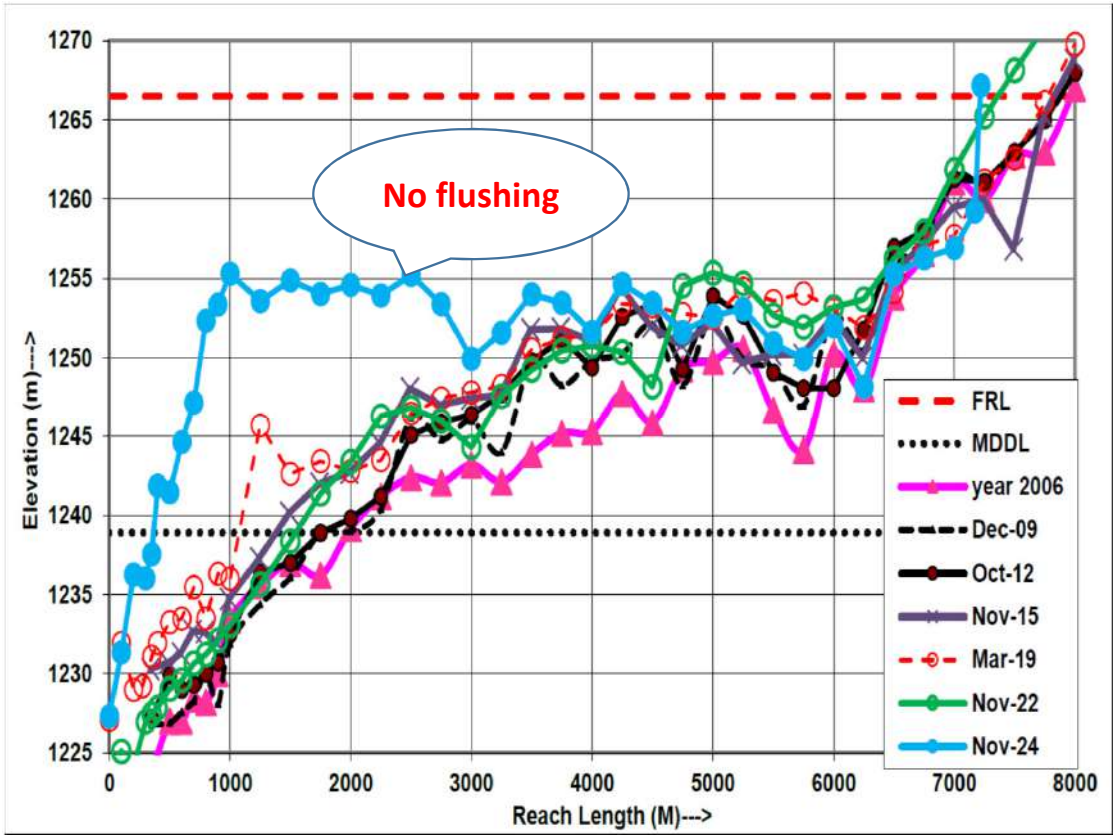
Intake Structure: Three levels at elevations 1226.5 m, 1242.0 m, and 1252.1 m, which **allows operational flexibility in minimizing sediment ingress** based on reservoir level and sediment load.

Desilting System: Sediment is intercepted by two Dufour-type desilting chambers (15 mx14.5 m x240 m, 170 m^2 each), with 90% efficiency for particles >0.3 mm.

DULHASTI POWER STATION
L-SECTION AND RESERVOIR CAPACITIES OVER THE YEARS



Variation of total and live capacities



Longitudinal bed profiles of the reservoir for different years from 2006 to 2024

CONCLUSION

- Himalayan rivers, on which **NHPC's power stations** are located, carry **much more sediment load** than **the capacities** available in the reservoirs of runoff the river power plants located in this region.
- Customized project specific **data-driven guidelines** based on the **reservoir size, valley shapes, sediment inflow & unique design features**, have been helpful in preserving the **reservoir capacity** and **ensuring smooth running** of power plant,.
- The success of sediment management in NHPC's power plants is rooted in its **deep-seated spillway design.**
- The **integration of structural and operational measures** ensure that sediment is intercepted, routed, and removed before it can damage turbines or reduce reservoir capacity.
- This approach is **cost-effective, sustainable, and replicable** for similar Himalayan hydropower projects.

THANK YOU

