

SEDIMENT AS A RESOURCE

Pathways To Reservoir Recoupment In Keralam

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Why Reservoirs matter to Keralam

The reservoirs of Keralam are lifelines for the state—storing monsoon runoff from the Western Ghats and releasing it through the year for four essential purposes:

Hydropower

Peaking power generation for the state grid, especially through the monsoon.

Irrigation

Regulated water supply for paddy and plantation agriculture across command areas.

Drinking Water

Source for major water treatment plants, e.g. Aruvikkara for Thiruvananthapuram city.

Flood Moderation

Cushioning capacity that attenuates monsoon flood peaks downstream.

The Statewide Siltation Challenge

Kerala's Water Network

84	62	20	2
Total Dams	KSEB	Irrigation	Water Authority

Irrigation Reservoir's Capacity Loss

Original: 1.575 BCM

⬇

Present: 1.140 BCM



How Sedimentation Occurs

1



Catchment Erosion

Deforestation, quarrying and unregulated agriculture loosen topsoil in the Western Ghats catchments.

2



Sediment Transport

Monsoon runoff carries silt, sand and debris downstream through rivers and streams.

3



Deposition

As water enters the reservoir, flow slows and sediment settles on the reservoir bed.

4



Capacity Loss

Repeated year-on-year deposition steadily shrinks live and dead storage volume.

Left unmanaged, this cycle repeats every monsoon—compounding storage loss year after year.

Bathymetric Studies Undertaken By Kerala Engineering Research Institute KERI



Sedimentation Division of KERI, under Water Resources Department conducts bathymetric studies to compute the present capacity of reservoirs and other water bodies like Eri, Wetland, Lake etc using

Integrated Bathymetric System (IBS) - Comprising Echo sounder MIDAS SURVEYOR MX-610 and DGPS- SIMRAD MX-610

Sub Bottom Profiler - To ascertain the underwater profile of the sediment layer

Softwares used

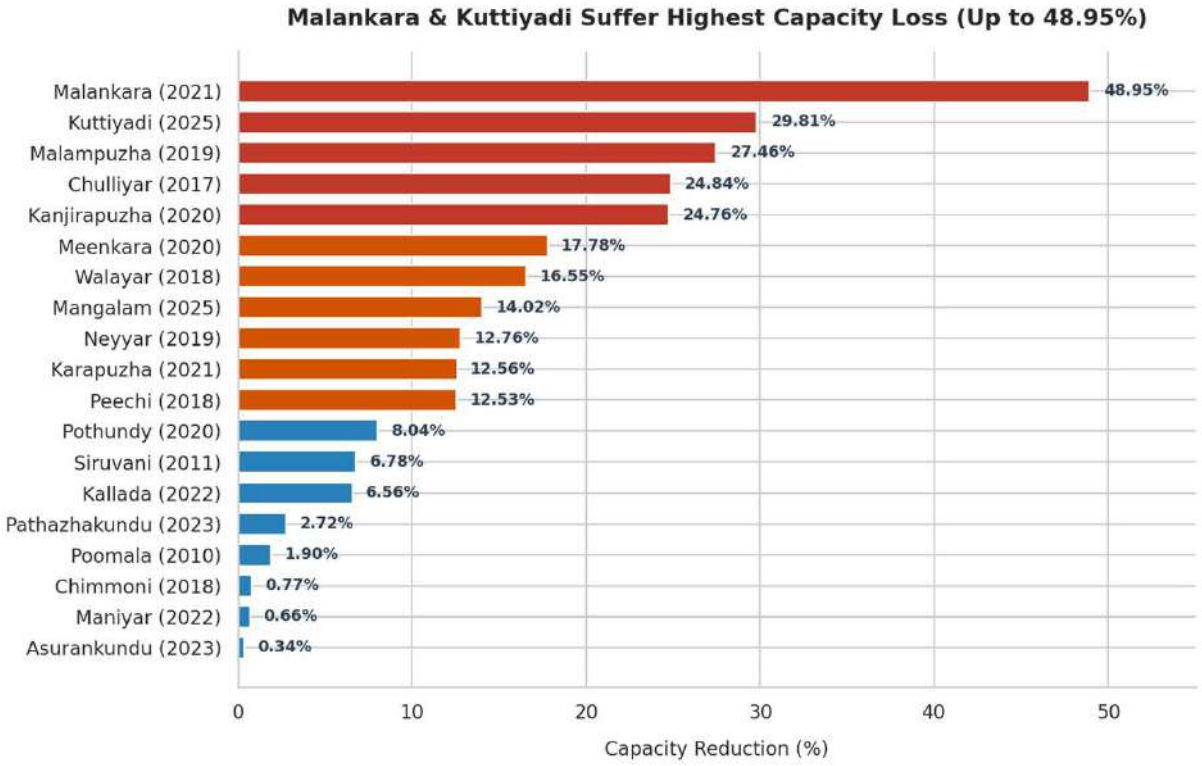
QINSY Software -data collection and processing in IBS survey

SESWIN - data acquisition and ISE 2.9.2 Data processing for Sub Bottom Profiler

KERI Completed 71 sedimentation studies including repeat studies for 24 dams of the state .

RESERVOIR SEDIMENTATION ANALYSIS

Percentage Reduction in Reservoir Capacity (%)



CRITICAL CAPACITY LOSS

Malankara: 48.95%

Malankara has lost nearly half its capacity (from 36.36 Mm^3 to 18.56 Mm^3). Kuttiyadi follows closely at 29.81% reduction.

HIGH RISK CLUSTER (>20%)

5 Reservoirs >20% Loss

Includes Malampuzha (27.46%), Chulliyar (24.84%), and Kanjirapuzha (24.76%), requiring prioritized desiltation planning.

MODERATE TO LOW LOSS (<10%)

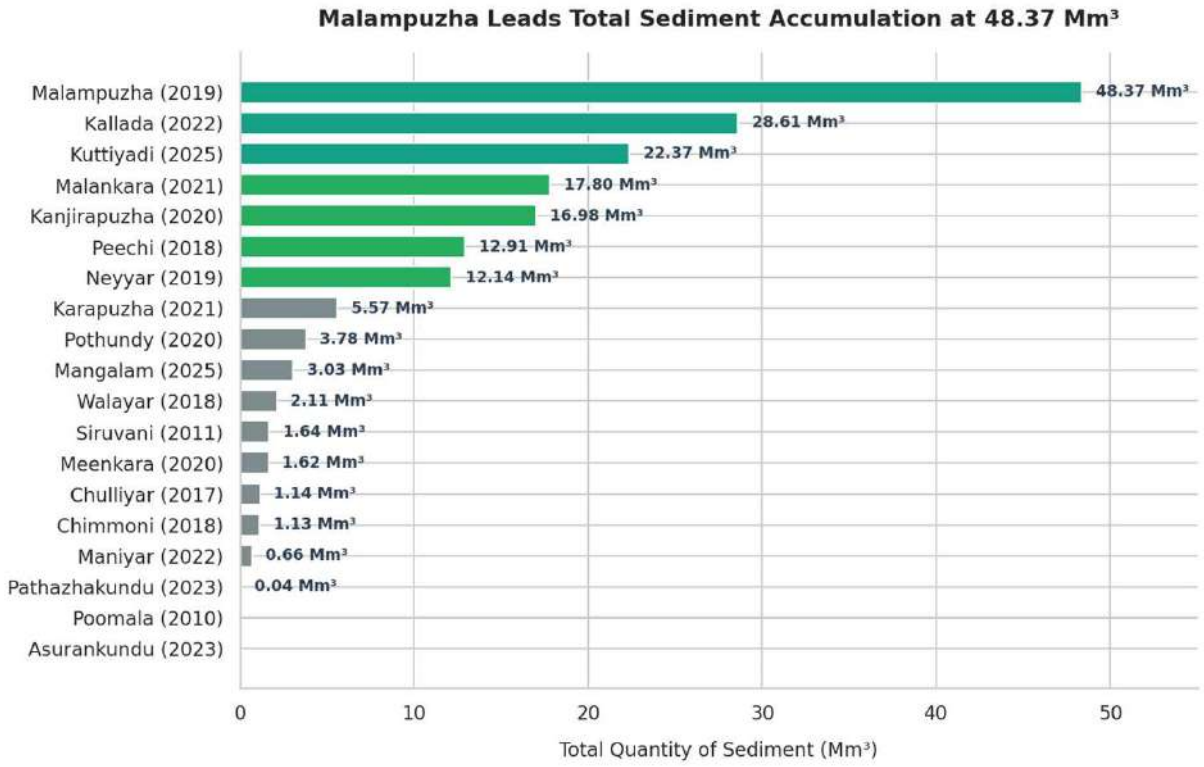
Min Capacity Impact

Dams like Kallada (6.56%) and Chimmoni (0.77%) exhibit low percentage loss .

Water Resources Department | Government of Keralam— KERI Peechi Sedimentation Study Report

RESERVOIR SEDIMENTATION ANALYSIS

Total Accumulated Sediment Quantity (Mm³)



LARGEST SEDIMENT DEPOSITS

Malampuzha: 48.37 Mm³

Malampuzha holds by far the highest absolute volume of trapped sediment (48.37 Mm³), followed by Kallada (28.61 Mm³) and Kuttiyadi (22.37 Mm³).

TOTAL SYSTEM CAPACITY LOSS

163.14 Mm³ Total Lost

Across all surveyed reservoirs at survey levels, total capacity decreased from 1,303.50 Mm³ to 1,140.36 Mm³, resulting in an overall system storage reduction of ~12.5%.

Consequences: Beyond Lost Storage

Higher Flood Risk

Reduced cushioning capacity means reservoirs absorb less of the monsoon peak. The “hungry water” effect after the 2018 floods intensified downstream erosion and channel scouring.

Water Security Strain

Cities and irrigation commands lose buffer days of supply. Desilting Aruvikkara, for example, could improve its supply window for Thiruvananthapuram city.

Power Generation Loss

Sediment intrusion near intakes accelerates turbine wear and reduces effective head, denting hydel efficiency.

Dam Safety Concerns

Altered load distribution along with reservoir-linked seismicity add to structural risk considerations.

Institutional & Policy Response

2016

CM-level directive

A high-level meeting directs preparation of a Standard Operating Procedure (SOP) for reservoir desiltation, coordinated across the Water Resources Dept., KSEB, Kerala Water Authority, Forest Dept., Mining & Geology Dept., NCESS and CWRDM.

2017

Pilot projects approved

Government sanctioned desiltation of Mangalam and Chulliyar dams as pilots projects.

SOP

Phased timelines by sediment volume

2017- Below 2 Mm^3: 12 months • 2–5 Mm^3: 24 months • 5–10 Mm^3: 36 months • Above 10 Mm^3: 60 months

2019- Below 5Mm^3: 12 months • 5–15 Mm^3: 24 months • 15–30 Mm^3: 36 months • Above 30 Mm^3: 48 months.

Safeguards

Environmental conditions

Mitigation plans required for silt transport and treatment; untreated water is not to be discharged into rivers or the reservoir under any circumstance.

The Empowered Committee & Technical Committee

Empowered Committee

1. The Chief Secretary -Chairman
2. The Additional Chief Secretary, Water Resource Department – Convenor.
3. The Additional Chief Secretary, Finance Department – Member
4. The Additional Chief Secretary, Power Department - Member
5. The. Additional Chief Secretary, Revenue Department - Member
6. The Additional Chief Secretary, Forest & Wild life Department- Member

The role of Empowered Committee are listed below:-

- Scrutiny of the DPR in consultation with the Chief Technical Examiner.
- Decide and approve the bidding method (Method 1- Turn key Method or Method 2- Work contract) to be adopted for a particular project in consultation with Chief Technical Examiner.
- Fixation of instalment amount to be paid to the Government for Method 1-Turn key Method.
- Approval of variation in the estimated quantity of total sediments and realised total quantity in consultation with the Chief Technical Examiner.
- Monitoring the progress and redressal of disputes, if any, arised during execution of work.

Technical Committee

1. The Chief Engineer (I&A)-Chairman
2. The Chief Engineer in charge of the Project-Convenor
3. The Chief Engineer (Mechanical), PWD-Member
4. The Director, Mining and Geology Department -Member
5. The Chief Hydrographer-Member
6. Assosciate Professor,NIT,Kozhikkode - Member
7. Assistant Professor,IIT ,Palakkad- Member
8. Director,KERI,Peechi. Member
9. The Superintending Engineer in charge of the project- Member

The role of *Technical* Committee are listed below:-

The Technical Committee shall give approval for Estimated quantity of components in the deposited sediments as well as estimated cost of each component material/ Estimated cost for extraction, processing and packing etc. of each component material.

Bidding Methods

Method 1: Turn-key method

•The Project authority shall assess the Probable Amount of Contract i.e, *The department shall work out the cost for the entire process including the separation and packing stage. The value of the separated components shall also be worked out based on current DSR in m^3.*

• The Project authority shall tender for outright sale of extracted components

•The bidders shall quote a lump sum amount to be paid to the Government

•The bidder who quotes the maximum amount will be the successful bidder

•The successful bidder shall pay the amount to the Government in advance in instalments as decided by the Empowered Committee and shall carry out the entire desiltation process as well as separation and sale of the components.

Method 2: Work Contract method

•After assessing the Probable Amount of Contract based on the cost incurred for extraction and separation of sediments the Project authority shall tender the work of extracting the sediments and separating components including packing as specified in the bid.

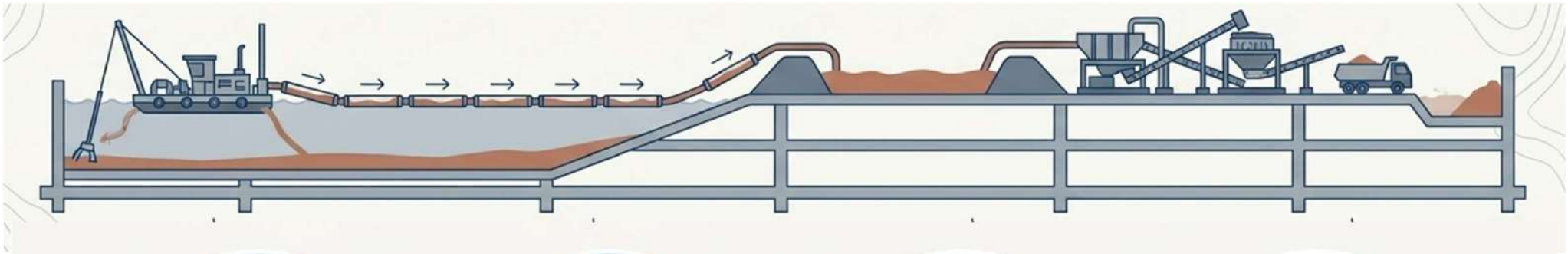
•The bidder shall quote unit rate (per cubic meter) for the total sediment for the work.

•The bidder who quotes the lowest rate will be the successful bidder

•After separation of components, the products shall be handed over to the District Collector concerned for disposal

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DESILTATION PROCESS





Phase 1: Removal

Extracting sediment material from the reservoir using floating pumps and dredgers.

Phase 2: Transportation

Moving dredged material via pipeline to separation plants and stacking yards.

Phase 3: Separation & Washing

Isolating and washing cobble, pebble, sand, and clay for resource categorization.

Phase 4: Distribution

Loading usable sand for market distribution and managing safe debris disposal.

CHULLIYAR DAM –CASE STUDY

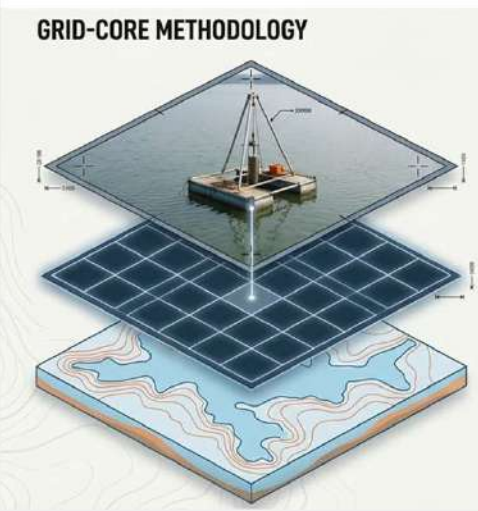


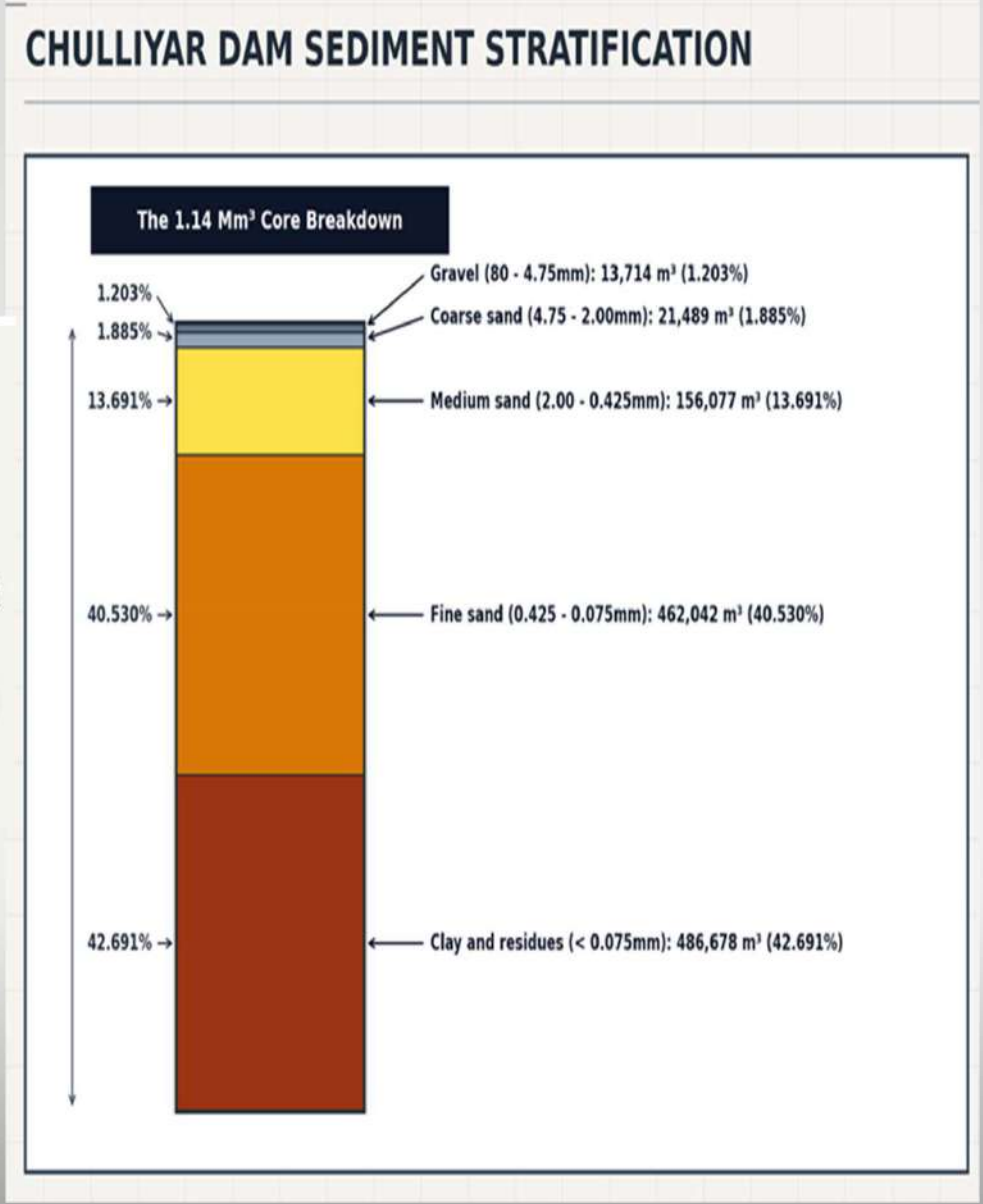
Parameter	Details
Location	**Chulliyar River (Bharathapuzha Basin)**
Commissioned	**1966**
Dam Type	Composite: Masonry gravity dam with a zoned earthen embankment
Total Length	1,755 m (Masonry section: 555 m; Earthen section: 1,200 m)
Catchment Area	**29.78 km²**
Water Spread Area	**1.65 km²**
Original Capacity	**13.733 Mm³**
Calculated Capacity (2017)(4.589 Mm3)	**3.449 Mm³**
Capacity Reduction	**24.84%**
Total Sediment Volume	**1.14 Mm³**

CHULLIYAR DAM –CASE STUDY

CORE SAMPLING

- The 1.65 sq km water spread area is systematically divided into 680 grids (50m x 50m micro-grids across reservoir bed).
- Underwater Gravity Core Samplers were used to collect samples from center of each grid, ensuring mathematical accuracy.
- 680 total core samples extracted and tested across the reservoir bed
- Average Core Depth =0.87 m











Different Stages of Desiltation works in Chulliyar Dam



CHULLIYAR RESERVOIR

MANGALAM DAM –CASE STUDY

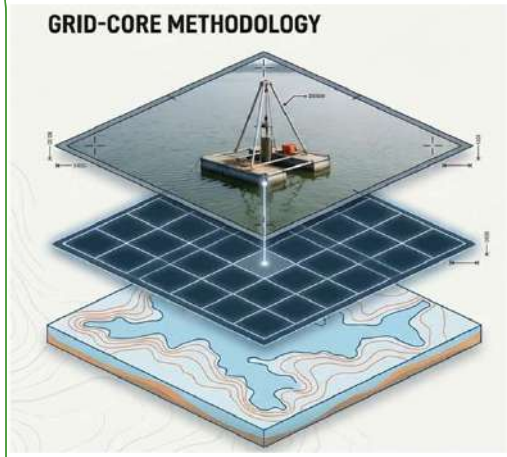


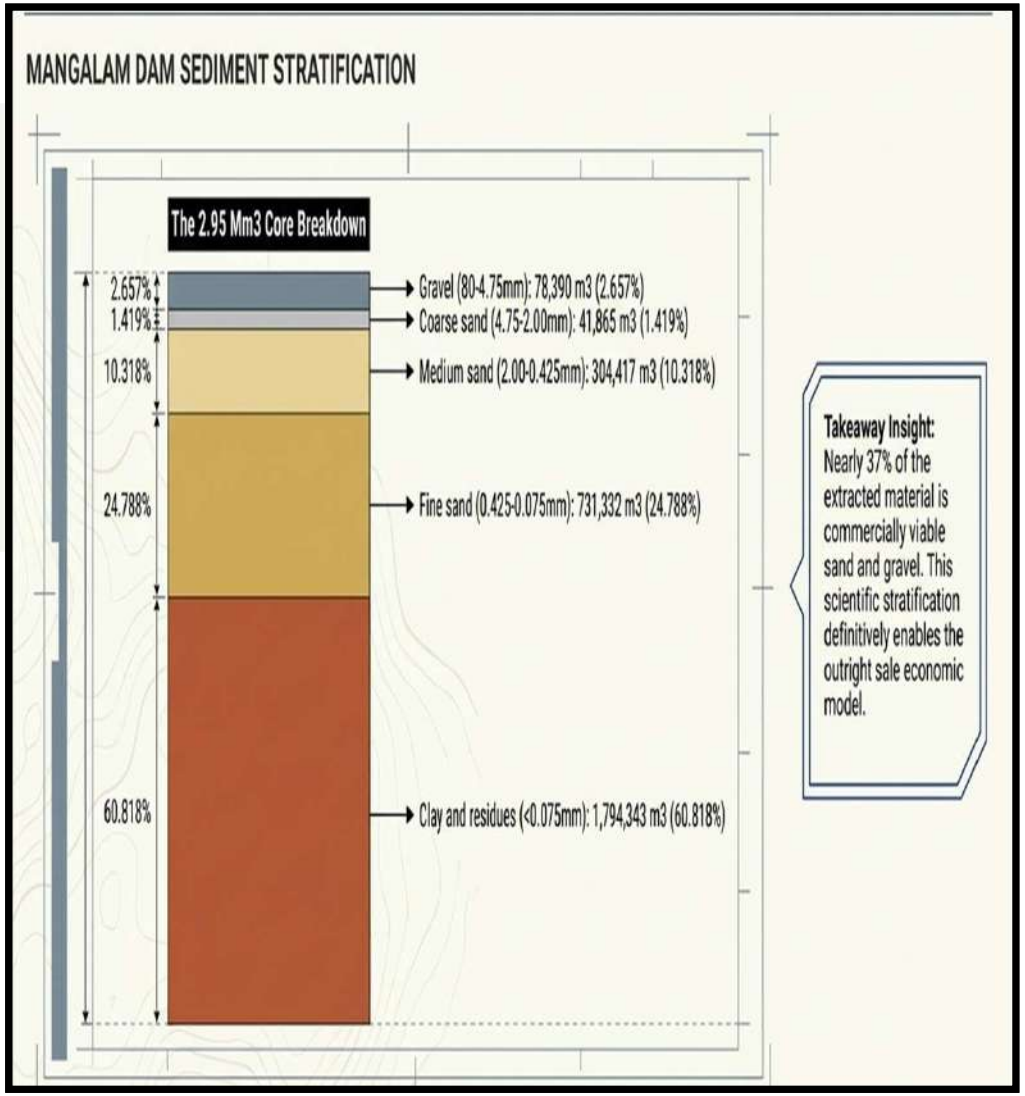
Parameter	Details
Location	Cherukunnapuzha River, a tributary of Mangalam River (Bharathapuzha Basin), Palakkad
Commissioned	1966
Dam Type	Composite: Masonry gravity dam with a zoned earthen embankment
Total Length	1,064 m (Masonry section: 162 m; Earthen section: 902 m)
Catchment Area	48.85 km²
Water Spread Area	3.93 km² (at FRL)
Original Capacity	25.494 Mm³
Calculated Capacity (2025 Survey) (21.639Mm3)	18.606 Mm³
Capacity Reduction	14.02% (3.03 Mm³)
Total Sediment Volume	3.03 Mm³

MANGALAM DAM –CASE STUDY

CORE SAMPLING

- The 3.96 km2 water spread area is divided into 93 zones (200m x 200m). Each zone is subdivided into 50m x 50m micro-grids
- Underwater Gravity Core Samplers extract samples from center of each grid, ensuring accuracy.
- 1,105 total core samples extracted. Cores are divided into 50cm lengths, yielding 2,498 individual sediment samples for component testing.
- Average Core Depth =1.08 m





DESILTATION WORKS IN MANGALAM DAM



Site Action: Dry Excavation Phase



Site Action: Slurry Collection Bunds



Site Action: Pass Issue at Outpost

DESILTATION WORKS - PROGRESS



CHULLIAR DAM

Model: Turnkey Basis

Sediment Target: 1.14 Mm3



WALAYAR DAM

Model: Work Contract Basis

Sediment Target: 2.11 Mm3



MEENKARA DAM

Model: Work Contract Basis

Sediment Target: 1.62 Mm3



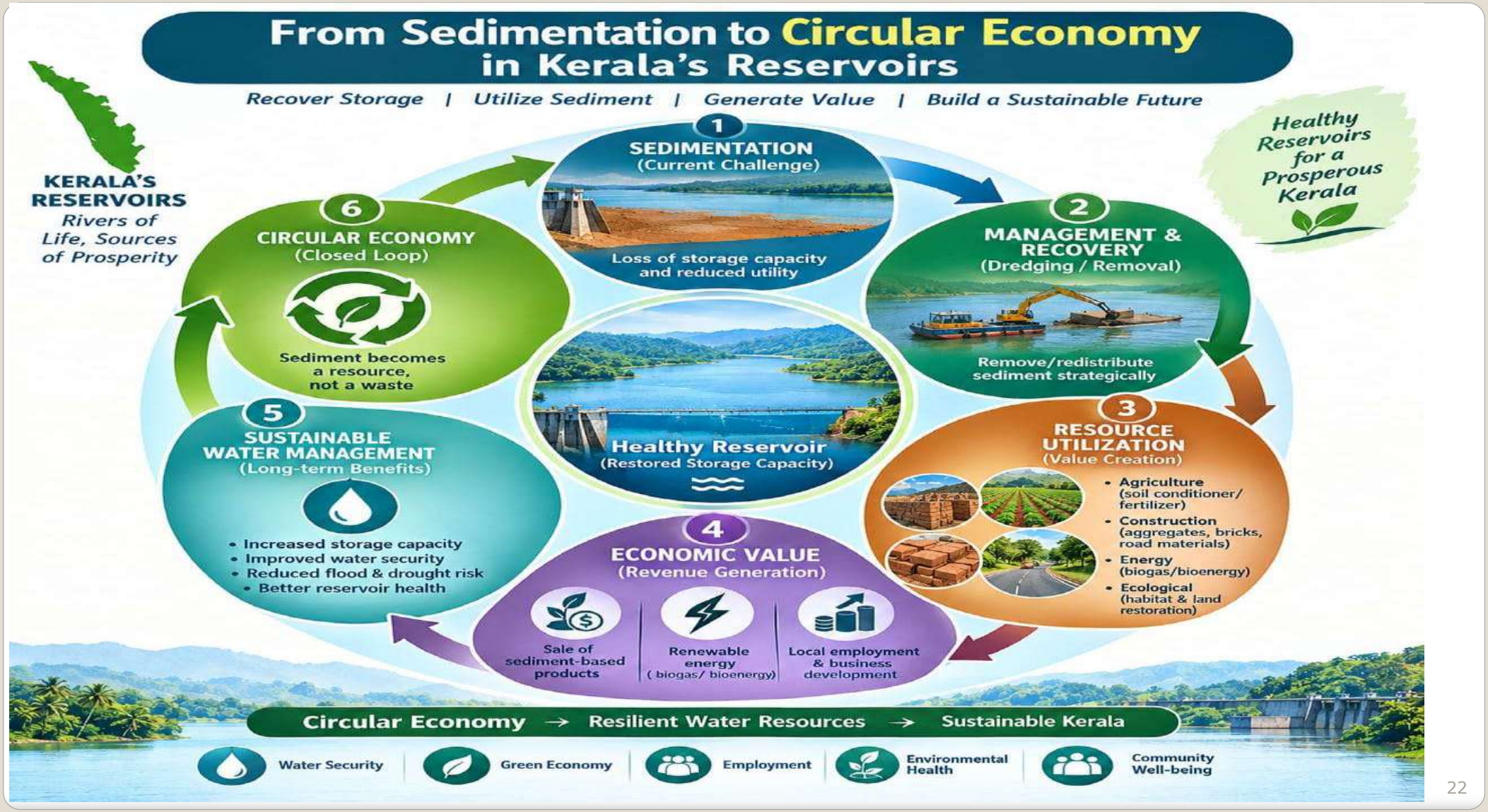


Walayar Dam





Meenkara Dam


From Sedimentation to Circular Economy in Kerala's Reservoirs
Recover Storage | Utilize Sediment | Generate Value | Build a Sustainable Future
KERALA'S RESERVOIRS
Rivers of Life, Sources of Prosperity
Healthy Reservoirs for a Prosperous Kerala
1
SEDIMENTATION
(Current Challenge)
Loss of storage capacity and reduced utility
2
MANAGEMENT & RECOVERY
(Dredging / Removal)
Remove/redistribute sediment strategically
3
RESOURCE UTILIZATION
(Value Creation)
Agriculture (soil conditioner/ fertilizer)
Construction (aggregates, bricks, road materials)
Energy (biogas/bioenergy)
Ecological (habitat & land restoration)
4
ECONOMIC VALUE
(Revenue Generation)
Sale of sediment-based products
Renewable energy (biogas/ bioenergy)
Local employment & business development
5
SUSTAINABLE WATER MANAGEMENT
(Long-term Benefits)
Increased storage capacity
Improved water security
Reduced flood & drought risk
Better reservoir health
6
CIRCULAR ECONOMY
(Closed Loop)
Sediment becomes a resource, not a waste
Healthy Reservoir
(Restored Storage Capacity)
Circular Economy → Resilient Water Resources → Sustainable Kerala
Water Security
Green Economy
Employment
Environmental Health
Community Well-being

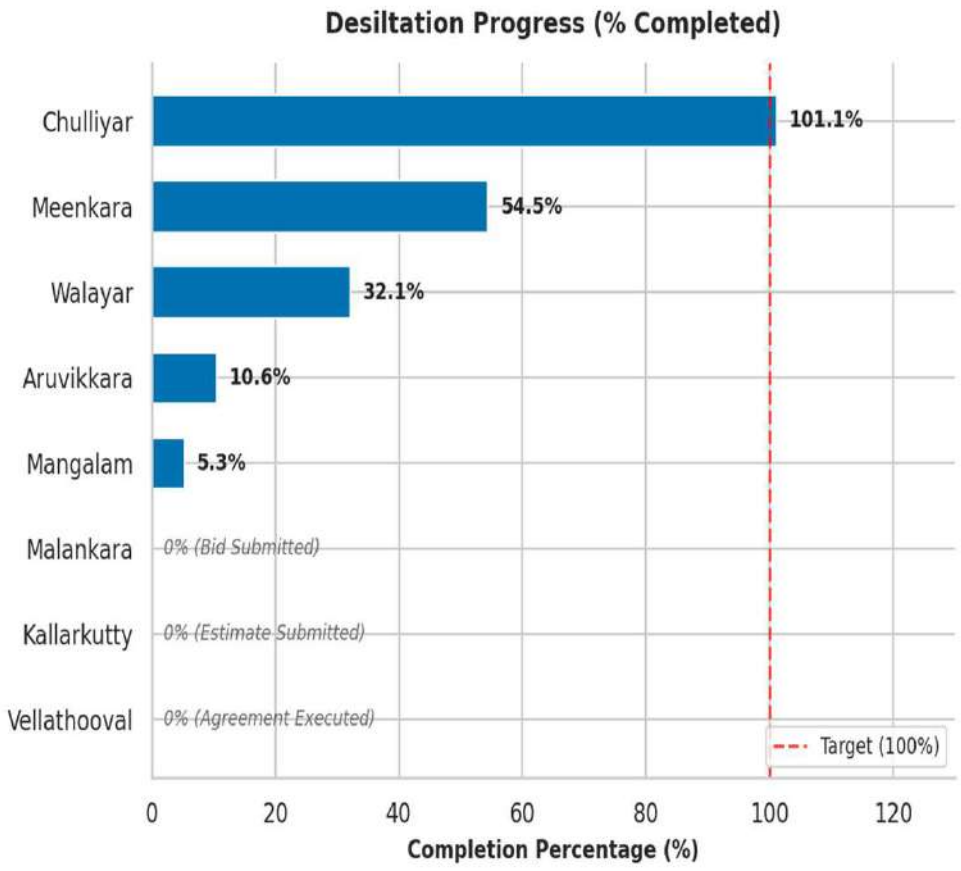
STATUS OF DESILITATION

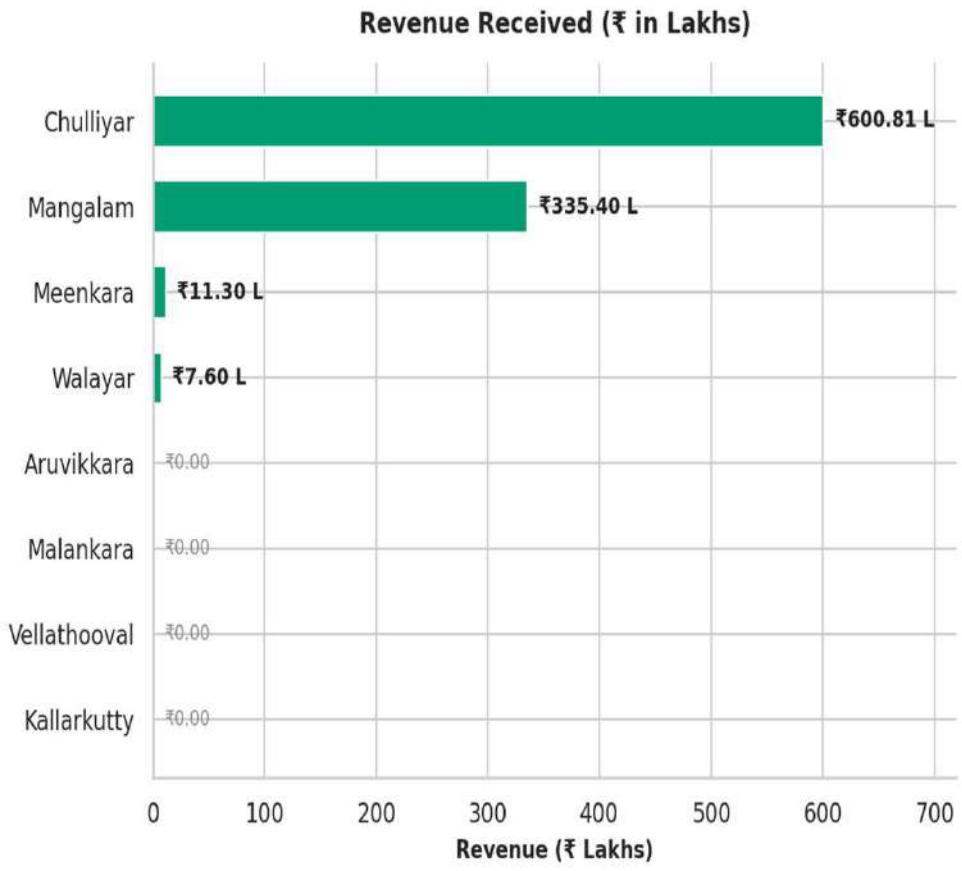
- **Desiltation of 8 Reservoirs are taken up**
- **1 work completed**

In addition Desilitation of 6 Irrigation Structures has been completed and 4 works are in progress. Revenue generated Rs. 3071 Lakhs

Name of Reservoir	Name of Agency	Estimated Quantity to be removed (M3)	Quantity removed (M3)	Status(%)	Revenue Share	Revenue Received (in Lakhs)
Mangalam	Irrigation	29,50,000	1,55,941	5.30	Full (Govt.)	335.40
Chulliyar	KIIDC	11,33,610	11,46,163	101.1	90:10 (Govt:KIIDC)	600.81
Meenkara	KEMDEL	11,28,472	6,14,440	54.45	75:25 (Govt:KEMDEL)	11.30
Walayar	KEMDEL	13,40,463	4,30,621	32.11	75:25 (Govt:KEMDEL)	7.6
Malankara	Irrigation	1,77,99,000		Financial Bid submitted for approval		
Aruvikkara	KIIDC	10,24,586	1,08,943	10.63	75:25 (Govt:KIIDC)	
Vellathooval	KIIDC	40,000		Agreement executed.		
Kallarkutty	KIIDC			The estimate was submitted to the KSEB for approval		
Total Revenue received						955.11

STATUS OF DESILITATION





Source: Status of Reservoir Desiltation Progress & Revenue Report

CHALLENGES IN DESILTATION PROCESS

1. Site Logistics (The Yard Bottleneck)

Site behavior under varying weather directly dictates progress. Vast yards for stacking and drying sediment must be definitively secured before finalization of the DPR to prevent workflow blockages.

2. Socio-Cultural Alignment

The attitude of the indigenous population is a primary success vector. Local labour integration and transparent communication are critical path items, not optional public relations.

3. Market Dynamics

Extraction must be rigorously paced with commercial demand. Advance market studies on the demand for specific dredged materials dictate the extraction rate to prevent yard overflow.

4. Supply Chain & Capability

Delays at pilot sites were driven by a lack of site-specific specialized machinery and professional staff. Future contracts must aggressively vet equipment and personnel availability beforehand.

Prevention: Catchment Area Treatment

The most cost-effective sediment control happens upstream—before soil ever reaches the reservoir.

Afforestation & Soil Conservation

Restoring vegetative cover on degraded upper-catchment slopes to bind soil and slow runoff velocity.

Check Dams & Contour Bunding

Small structures across gullies and slopes that trap sediment close to its source and reduce peak flows.

Regulating Quarrying & Mining

Tighter enforcement near catchment boundaries, where unregulated extraction is a major erosion driver.

Watershed Management

Terracing and contour farming on agricultural slopes within the catchment to limit topsoil loss.

Reservoir-Level Interventions

Where sediment has already reached the reservoir, structural and operational measures manage it directly.

Sediment Flushing & Sluicing

Low-level outlets are opened during high-flow periods to pass incoming sediment through rather than let it settle.

Mechanical Dredging & Desilting

Physical removal of accumulated silt from the reservoir bed to directly recover lost storage volume.

Sediment Bypass Systems

Tunnels or channels route sediment-laden flows around the reservoir during flood events.

Upstream Silt Traps

Small check structures upstream intercept coarse sediment before it reaches the main reservoir basin.

SEDIMENTATION & CIRCULAR ECONOMY

Recoupment of Storage: Desilting & Reuse

Embankment Strengthening

Reinforces flood bunds and critical reservoir embankments.

Construction Materials

Yields commercial-grade sand without riverbed mining.

Agricultural Soil Enrichment

Supplies nutrient-rich topsoil to boost farmland fertility.

Brick-Making & Construction Fill

Replaces quarried raw materials for local infrastructure.

Beneficial reuse offsets desilting capital expenditure while converting a disposal challenge into a sustainable local revenue stream.

KEY BOTTLENECKS

Why Progress Has Been Slow

Core operational and economic hurdles in reservoir desilting

Silt Disposal Logistics

Transporting and safely disposing of large sediment volumes raises environmental and logistical hurdles.

High hauling costs & disposal constraints

Limited Private Participation

Tenders for desiltation works have drawn minimal contractor response..

Minimal Response from Contractors

Working Period

The working period is limited, as dams must maintain continuous water distribution schedules, which restricts desilting operations.

Constrained by mandatory water release

Addressing these bottlenecks requires scalable silt disposal plans, commercial off-take models, and dredging techniques compatible with active water management.

Modification of SOP - Recommendations

- To address the issues related with desiltation based on the experience and information received from Pilot projects as well as based on the discussion with field Engineers the followings suggestion has been submitted to Government for considerations
- Proposed to change the Grid size for investigation for preparation of DPR from the existing 200Mx200M to 500Mx500M to reduce the cost of investigation.
- Proposed additional bidding Model- Integrated Package (Bundled) to get competitive bidding.
- Proposed to enhance the contract period(Considering the actual Transportation plan, the working season etc…)
- Proposed to exempt the royalty and seigniorage to sediments having no construction value for attracting more bidders.

Recommendations for a Sustainable Path Forward

1. Mandate periodic (e.g. five-yearly) bathymetric or satellite-based capacity surveys for every major and medium reservoir.
2. Ring-fence an annual desiltation budget, phased by sediment volume as set out in the SOP timelines.
3. Scale up learnings from the Mangalam and Chuliyar pilots to high-priority dams.
4. Promote silt-to-resource value chains—agriculture, brick-making, embankment fill—to help offset costs.
5. Strengthen catchment protection through afforestation and stricter regulation of quarrying near catchments.
6. Establish a dedicated inter-agency reservoir sedimentation cell to coordinate - Irrigation, KSEBL, KWA, Forest Department efforts.

—CONCLUSION

Securing Water Future For Keralam

Sedimentation is a slow, cumulative threat to storage that Reservoirs In Keralam cannot outgrow on their own.Protecting water, power, and flood security means combining three things at once

Prevent

Catchment treatment & regulation

Recoup

Desilting, flushing & silt reuse

Monitor

Periodic satellite & survey data

Key Outcome: Restoring storage capacity ensures perennial drinking water, dependable hydropower, and enhanced flood buffering across Kerala's 44 river systems.

KERALA'S WATER SECURITY

"Every drop sustained today shapes a resilient Keralam tomorrow."

Thank You

Questions & Discussions