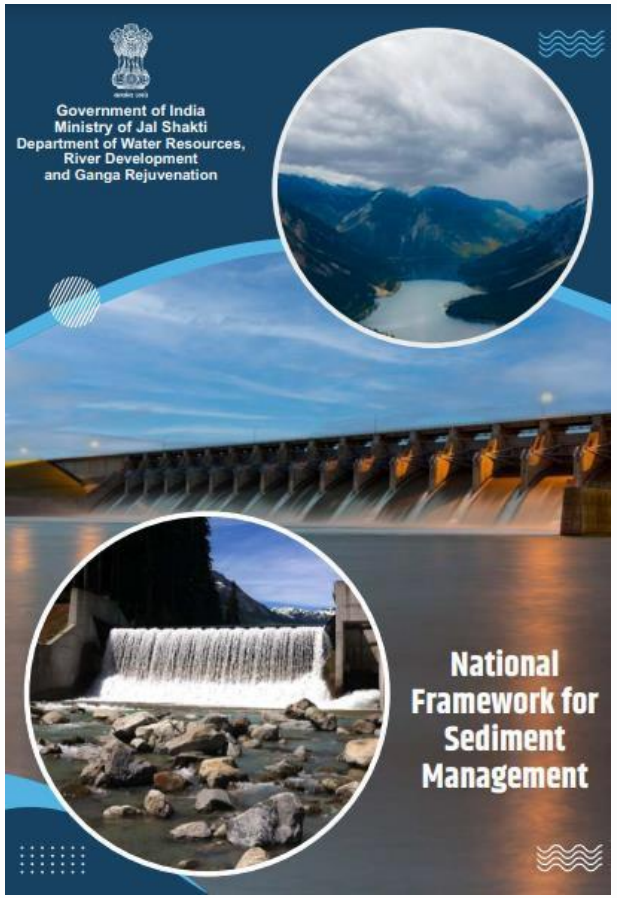
Government of J&K
JalShakti Department

Integrated Management of Sediments in River Basins and Reservoirs for Sustainable Development

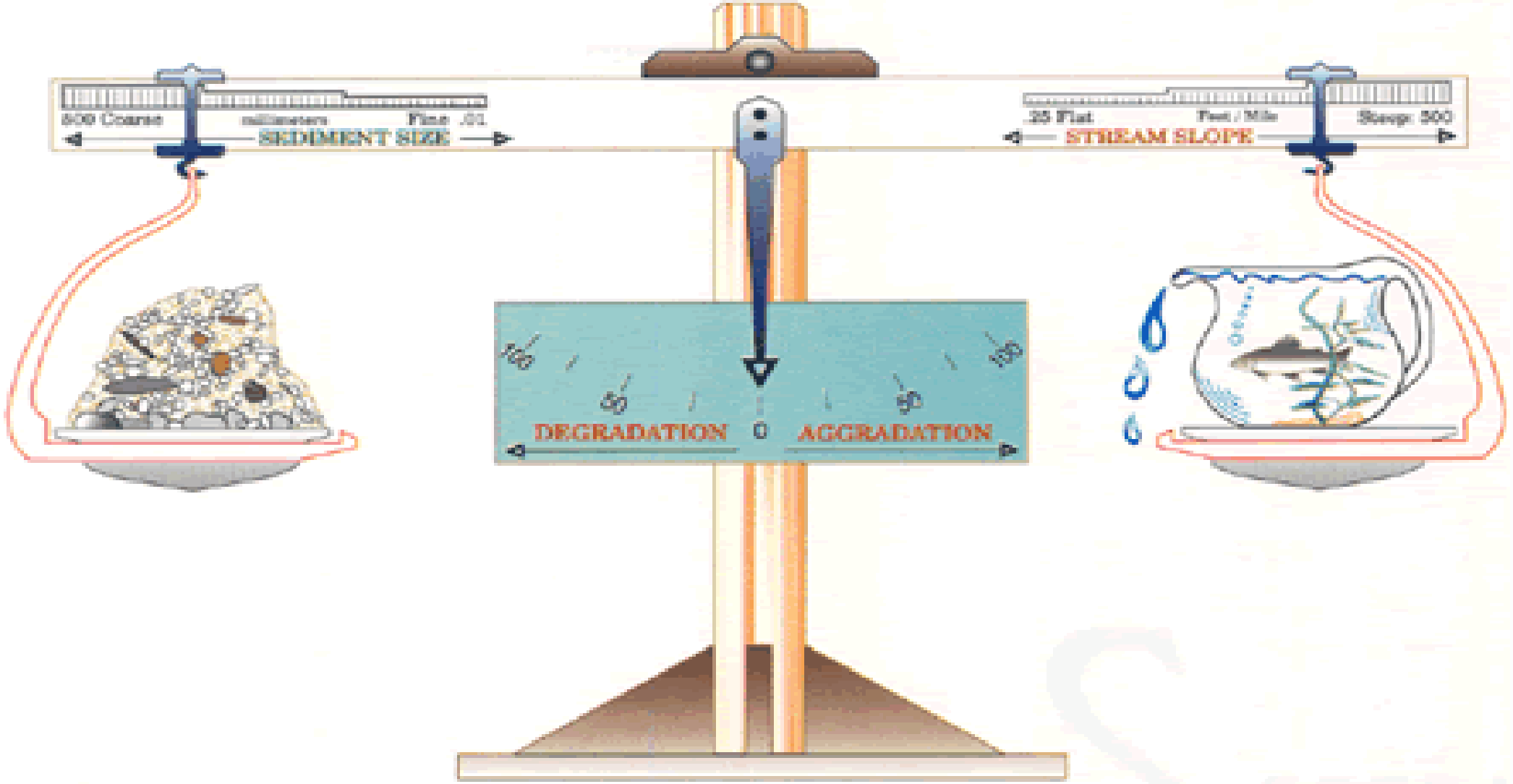


06.09.2023

Background

- Sediment transport is the movement of organic (humus, decomposing material such as algae, leaves etc.) and inorganic particles by water.
- Deposition and erosion of sediment along the length of river is a natural phenomenon.
- When underlying parameters of volume and velocities are disturbed, either due to lower gradient (entering into plain reaches) or encroachment in flood plain, widening of the channel (braiding of river streams), suspended silt particles in the river water settle down, this is called siltation.
- This phenomenon is normally called sedimentation when it occurs in a reservoir.

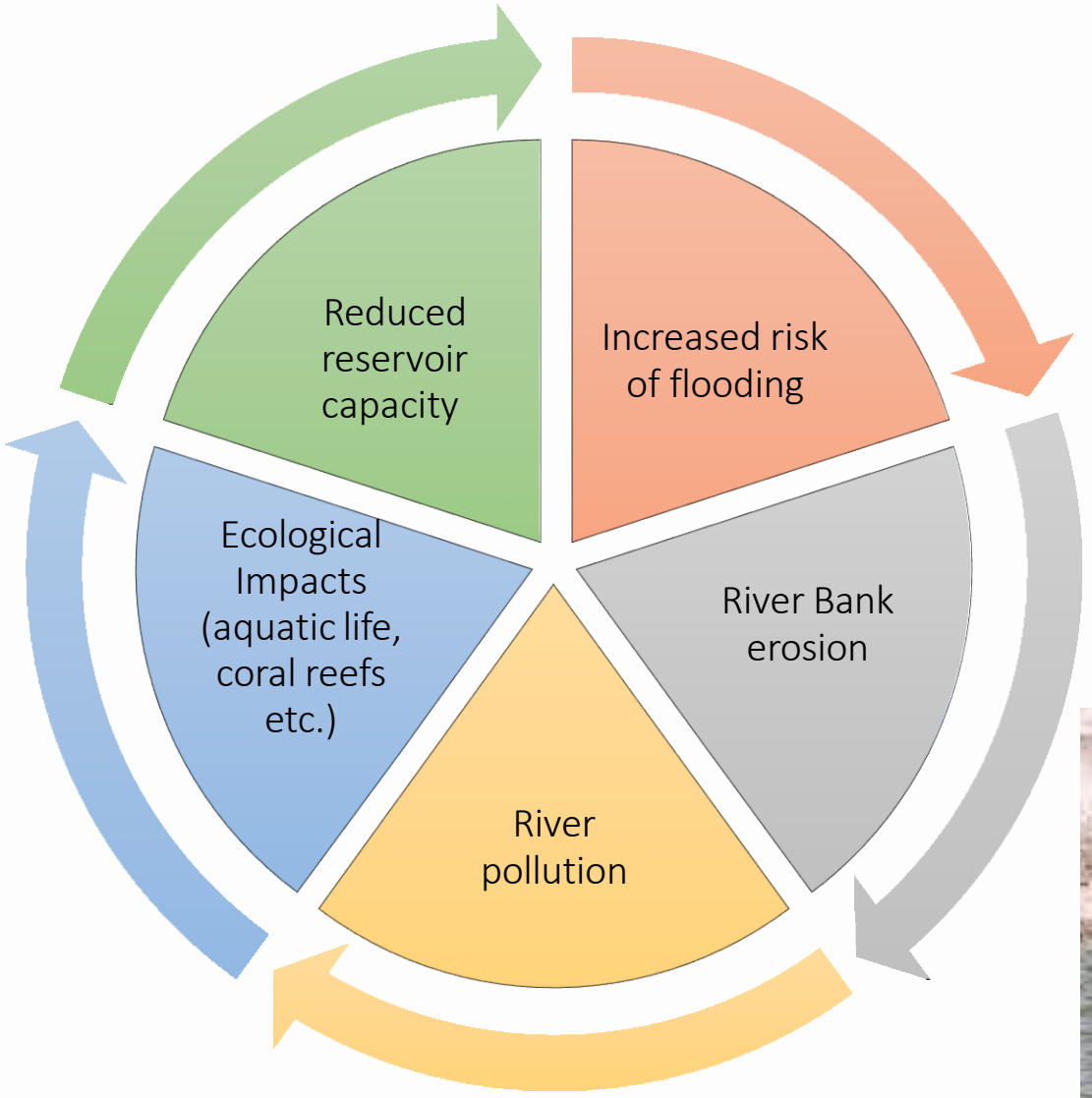
LANE 'S BALANCE ANALOGY



Major Causes of Sedimentation in River Basins

- Deforestation in Catchment Area
- Urbanisation of Flood Plains
- Encroachment in River Bed
- Unsustainable sand mining
- Unplanned river control works

Sedimentation : Adverse Impacts



Erosion

Sedimentation

Ecological

Sedimentation : Impact in Reservoirs

- Sedimentation results in loss of reservoir storage thereby reducing its benefits and reduced serviceable life.
- As per ICOLD, 50% of storage would be lost globally by 2050 and 100% within 200-300 years.

Large Dams in India:

Total Large Dams in India = 5745

Total Completed Dams = 5334

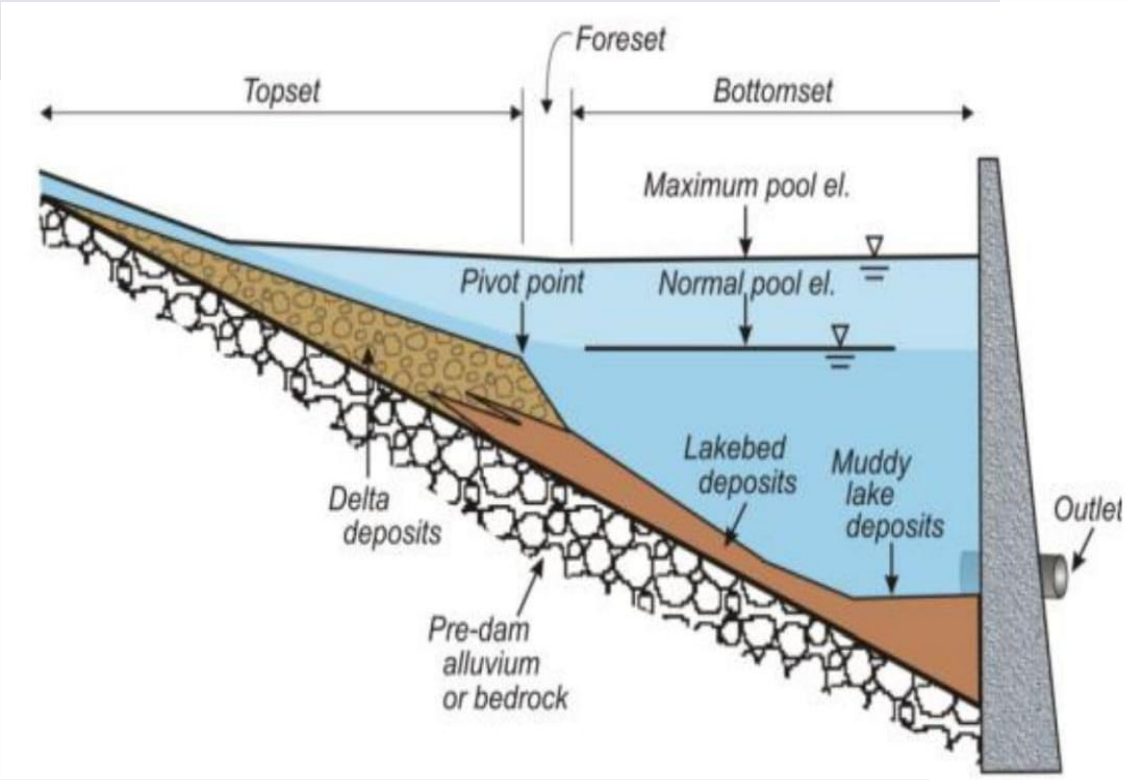
Large Dams in J&K

Total No's = 17

Completed Dams = 15

Source: National Register for Large Dams, 2019

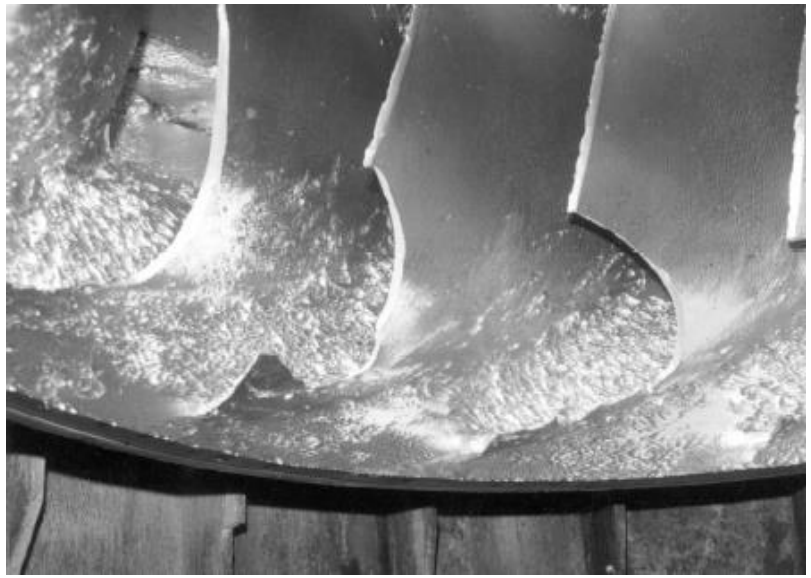
Central Water Commission



Reference: Handbook for assessing and Managing Reservoir Sedimentation

Sedimentation Problems in Hydro Electric Power Plants

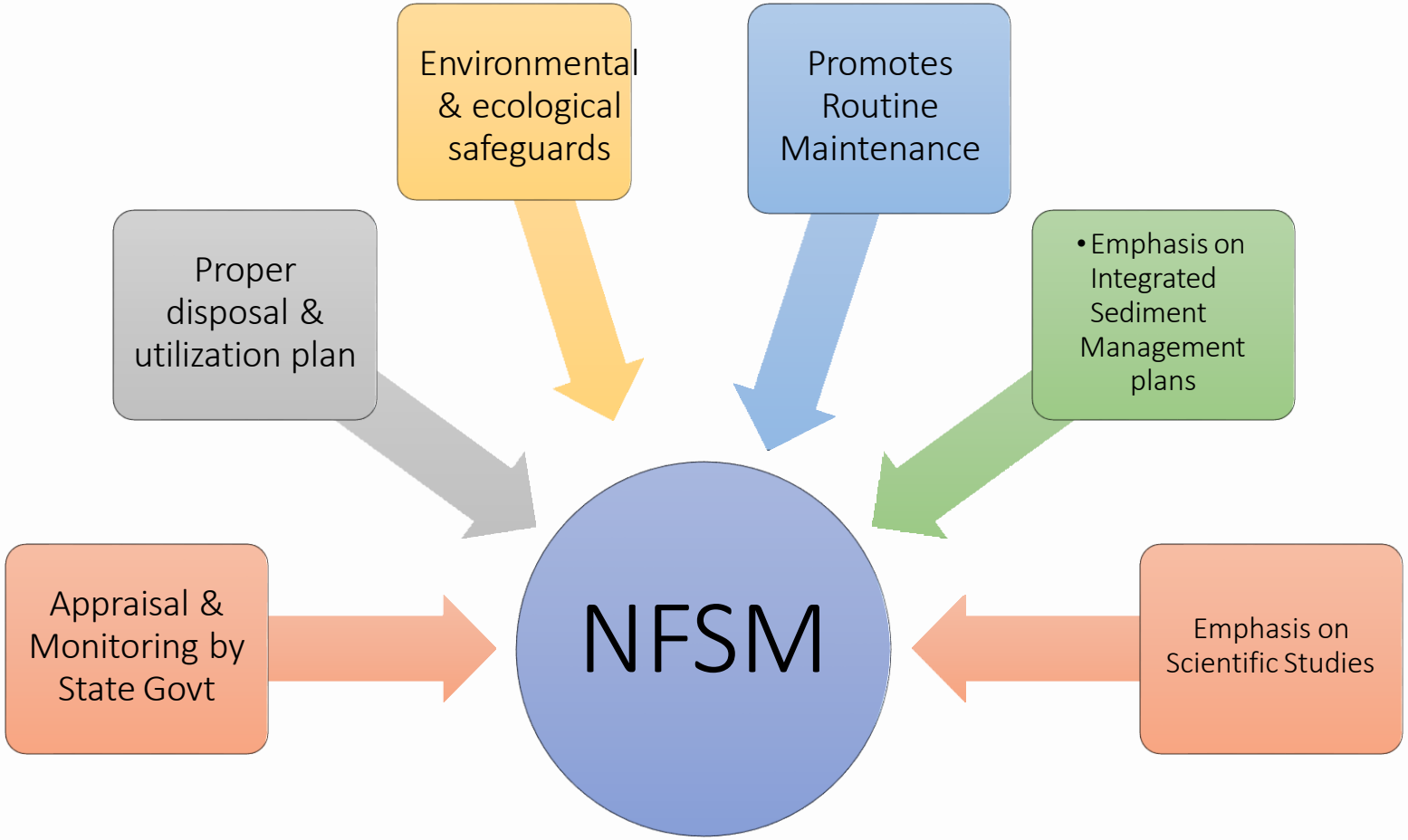
DAMAGE TO RUNNERS AND RUNNER BLADE

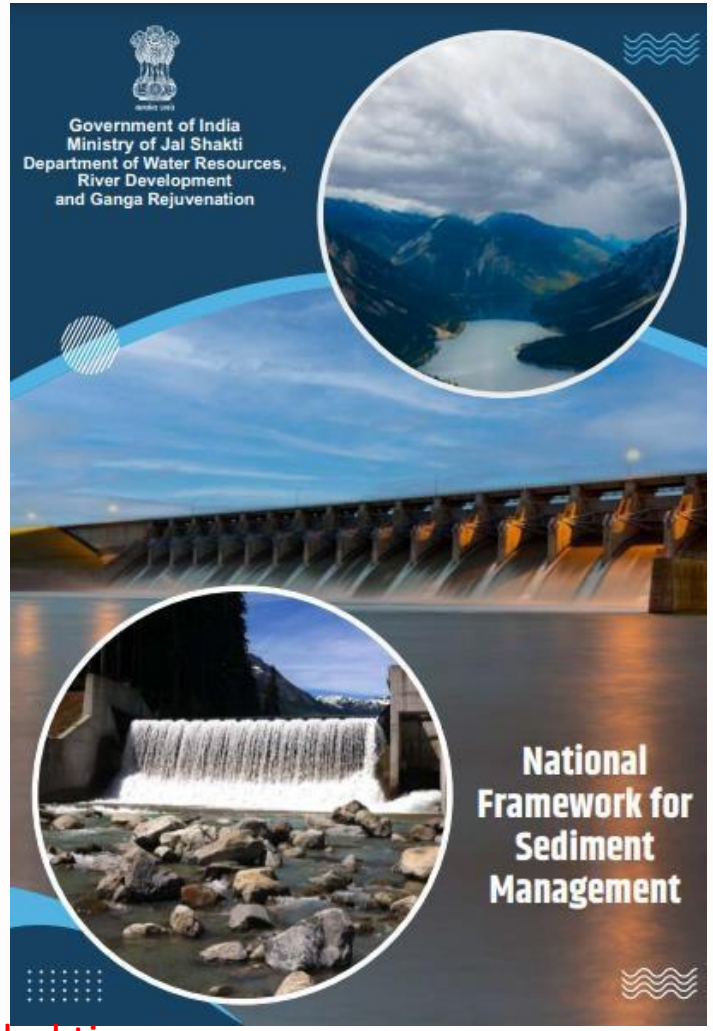


The **annual loss in generation** due to sedimentation has been estimated about **1% of the overall generation**.

Source: NHPC PPT

Key Highlights of NFSM





Released by Honourable Minister of Jal Shakti during the 1st All India Annual State Minister's Conference on Water Vision @2047 held during 05-06 January'2023 at Bhopal

Relevant Guidelines

Sand Mining	Sustainable Sand Management Guidelines of MoEF&CC,2016
Desilting of Reservoirs	Operational Procedure for Assessing and Managing Environmental Impacts in Existing Dam Projects, CWC, November, 2020
Water Bodies	Guidelines for the scheme on Repair, Renovation and Restoration (RRR) of Water Bodies under PMKSY (HKKP) – June, 2017
Watershed	Common Guidelines for Watershed Development Projects, 2008, DoLR, MoRD

Approach Towards Sediment Management

❑To reduce sediment production in the watershed sustainably, the main actions include:

(i) study watershed characteristics.

(ii) assess the vulnerability of watershed in terms of soil erosion & sediment production using modelling and to identify & prioritise the degraded micro-watershed for treatment.

(iii) treatment of the prioritised micro watersheds with biological and engineering erosion control measures.

(iv) stream bank erosion control using river training works like spurs etc., and

(v) trapping sediment upstream of in river before entering into reservoir .

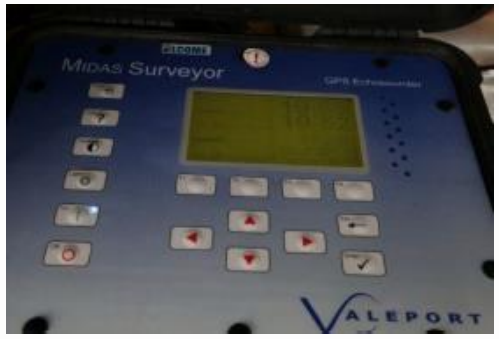
Measurement & Estimation of Sediments

A] **Stream flow analysis**

B] **Capacity survey**

1) Conventional Method

2) Modern Techniques



Echosounder

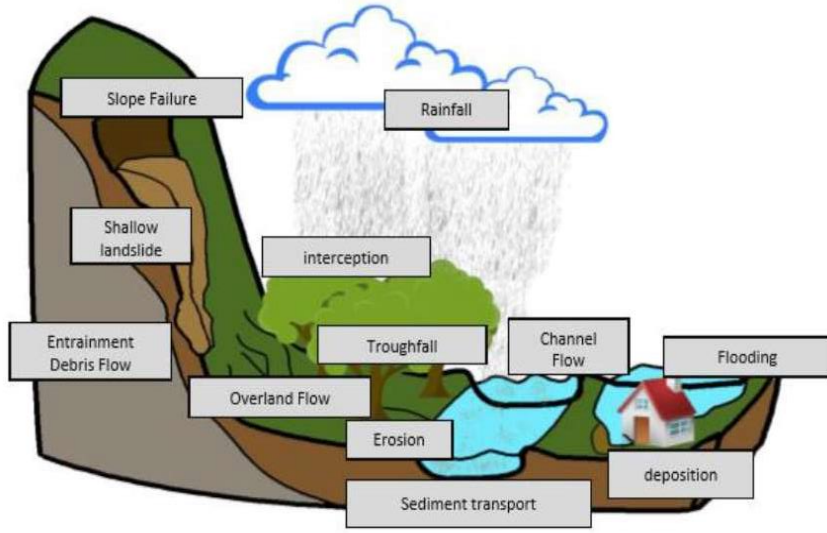
Sub-Bottom Profiler

- Hi-tech bathymetric system
- Satellite Remote Sensing Technique
- Hybrid Technique (Bathymetric with Satellite Remote Sensing)
- GNSS based field Differential Global Positioning System (DGPS)

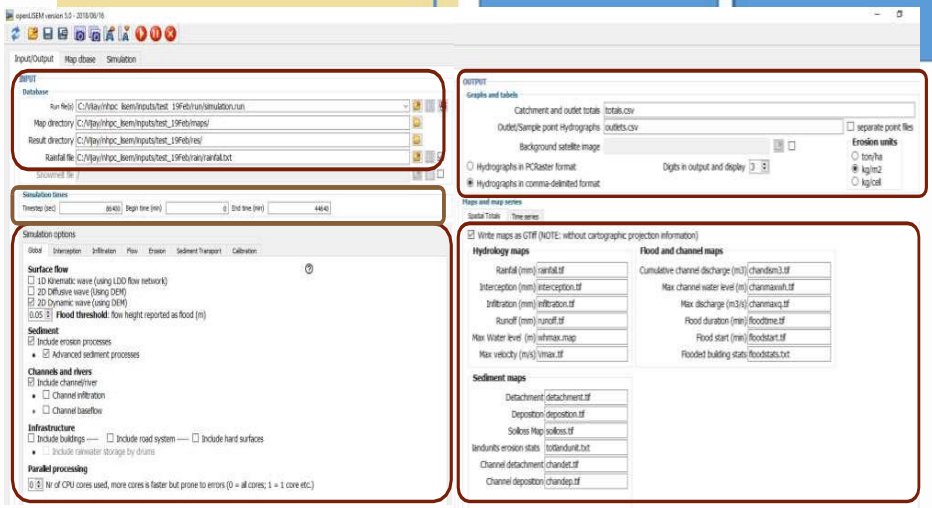
Remote Sensing in Sediment Estimation (NRSC)

Lisem (Lisem Integrated Spatial Earth Modeller) is a free and open-source software tool that allows users to manipulate geo-spatial data

	DEM	Land Use	Soil Types	Rainfall
Base Layers				
Extra Information	Corrected Elevation Channel Dim. Channel Loc.	Land Use Vegetation (NDVI) Urban elements	Soil Texture Classes Soil Depth	Rainfall -Stations Maps
Input maps required by LISEM model				
Resulting Maps prepared as input for LISEM model	Elevation Gradient LDD Channel LDD Channel Gradient Channel Width Channel Depth	Random Roughness Manning's N Vegetation Cover Vegetation Height Canopy Storage Litter Storage Building Cover Road Cover Rain Drums Crusted Fraction Compacted Fraction	Ksat Psi ThetaR ThetaI ThetaS Cohesion Internal Friction Angle Grain size Rock size Density Aggragate Stability	Rainfall Maps



Limburg Soil Erosion Model



LISEM Main interface

Simulation Results

Approach to Sediment Management in Watershed

- Assessment of land use changes over the time and soil erosion from the catchment
- Identification of hotspots areas
- Appropriate Catchment Area Treatment and land use planning

Contour Trenching

Staggered Trenching

Check Dam

Afforestation

Adoptable measures

Approach to Sediment Management in Rivers

- Regular Sediment Budgeting
- Periodical Monitoring of river morphological changes
- Non-structural measures:
  - ✓ Proper operation of gates of barrages/ weirs
  - ✓ Promote Sustainable Sand Mining
- Structural measures
  - ➢ Widening/Channelization/Deepening
  - ➢ Desilting/dredging/channel modification to be backed by scientific /model studies
  - ➢ Bank sides protection

Approach to Sediment Management in Reservoirs

- Integrated bathymetry survey with sub profiling sediment sampling at prescribed intervals.
- Non-structural measures:
  - Draw-down flushing
  - Pressure flushing
  - Sluicing
  - Venting turbidity density currents etc
- Structural measures
  - Diversion tunnel
  - Sediment traps etc
- Desilting/Dredging based on thorough assessment

Action Plan for Sediment Management

- Identification of hotspots may be carried out for prioritizing the action plans for Sediment Management thereby helping in targeted, cost-effective interventions.
- It is recommended to quantify the sediment load in order to identify effectiveness and type of interventions required (Studies & Measurements are Important)
- Action Plan for Sediment Management works will broadly involve three Components:

  1) Catchment Area Treatment Works in water shed (Forest, Soil Conservation, RDD)
  2) Sand Mining for the River Reaches (Geology Mining & IFC)
  3) Bank Protection works for Erosion Control (I&FC)
  4) Desilting of Irrigation Khuls/Canals/minors (Convergence Plan under MGNREGA)

Sand Mining :How to decide ?

Quantity of mining < Incoming sediment from u/s – Sediment carrying capacity of flowing water d/s

Sediment Budgeting & Replenishment Studies are indispensable

Sediment Transport in River Jehlum

- The physical erosion rate per unit area of the sediments for the upper Jhelum basin was estimated to be 240 tonnes/km^2/year (Source: Eptisa Study on Jehlum)
- Annual Sediment Load is estimated around **Ten Lac Cubic metres per annum** (Approx. 22 Lac tonnes annually)

Average Extraction of Sand alone
2014-22 = 4.60 Lac Tonnes annually

Average Total annual extraction
2014-22 = 10.0 Lac Tonnes annually

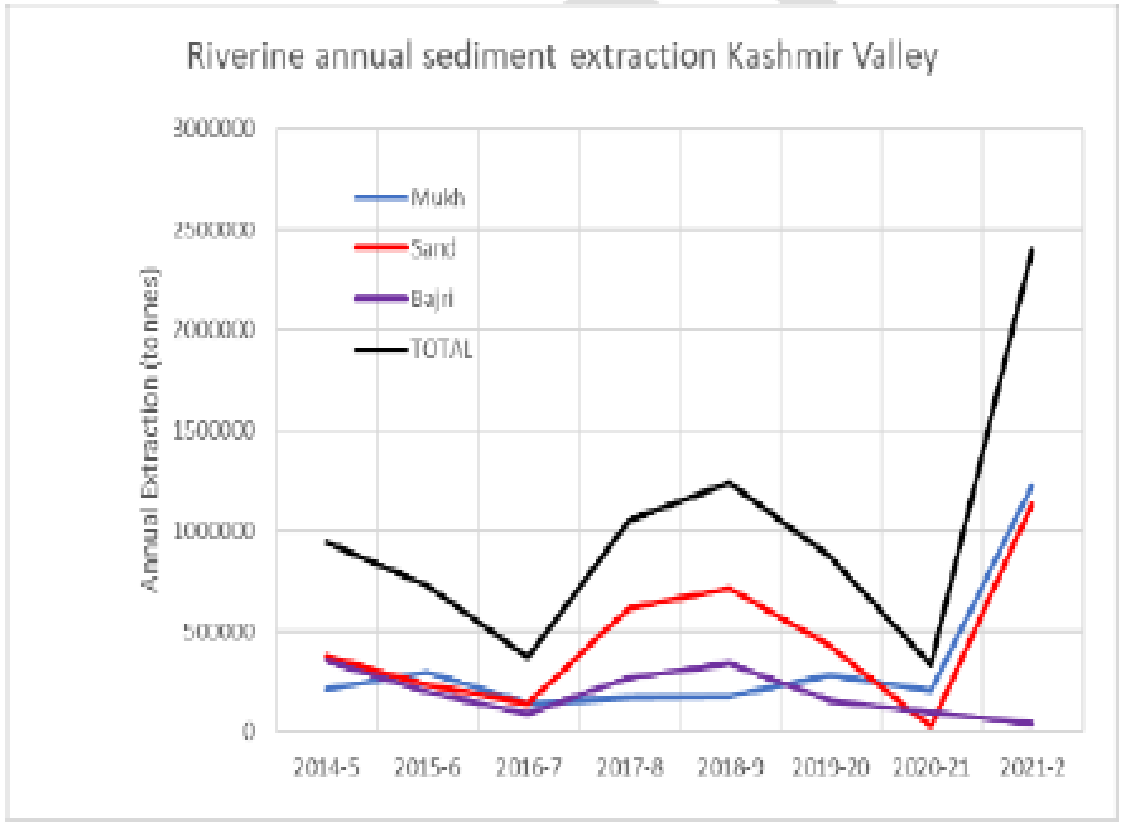


Figure 5-1: Annual Riverine Sediment Extraction Kashmir Valley 2014-2022
(Source: Dept of Geology and Mines)

Mining Restrictions& River Bed Degradation

- **SUSTAINABLE SAND MINING MANAGEMENT GUIDELINES-2016, MOEF & CC, NEW DELHI**
- The distance between sites for sand and gravel mining shall depend on the replenishment rate of the river.
- Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.
- Sand and gravel shall not be extracted within 200 to 500 m from any crucial hydraulic structure such as pumping station, water intakes, and bridges.
- "***Dredging and De-silting of Dams, Reservoirs, Weirs, Barrages, River and Canals for the purpose of their maintenance, upkeep and disaster management"*** **shall not be treated as mining** for the purpose of requirement of Environment Clearance.
- One can also refer to Restrictions highlighted for various manmade structures in Annexure III (pg. 29 to 31) of NFSM

Provisions of Dredging/Desilting in NFSM

National Framework for Sediment Management

Provisions of Dredging/Desilting

No clearance required for

- Navigation channel by IWAI
- Upkeep, maintenance and disaster management

Advisory – Not to cause pollution in river and not harm flora and fauna

- Coherent with existing/latest guidelines
- Safety of existing structures to be maintained

Allowed with safeguard

- Feasibility Report to include disposal/utilization plan.
- EIA Studies/Environment Management Plan
- Site clearances for dumping of spoil
- DPR to be cleared by state authority and approved by competent authority

Suggestive composition of State Technical Advisory Committee (TAC) for Techno-economic appraisal of Sediment Management Schemes

S No	Committee Composition	
1	Principal Secretary(Irrigation/Flood Control/ water Resources)	Chairman
2	Representative of State Finance Department	Member
3	Chief Engineer of CWC of concerned basin	Member
4	Representative from State Environment & Forest Department	Member
5.	Member (Technical). Inland Waterways Authority of India and Development Advisor (Ports) MoPSW.	Member
5	Representative from Dept of Mining	Member
6	Representative from District Administration of concerned area	Member
7	Engineer- in-Chief (Flood control/ Water Resources/ Navigation/ Irrigation)	Member
	Representative from Ministry of Earth Sciences	Member
8.	Representative from Building Construction Dept/ Road Construction Dept	Member
9.	Regional Officer, MoRTH/NHAI/NHIDCL	Member
10.	Member from Downstream State (in case of Inter State implication)	Member
11.	Chief Engineer/General Manager (Dam Owner/ Project Authority	Member Secretary

Extraction of Sediments for Economic Use: NFSM

- Sediment deposit in both rivers and reservoirs at some places contains considerable quantity of sand.
- In places where sediment deposits are having good sand content (of the order of 70% - 80%), it is possible to extract sand from sediment to meet the ever-increasing demand of sand.
- Sediment component such as silt and clay bears comparatively lesser economic value but still can be used in many works such as for brick making, as filling material, construction of embankments, roads, etc.
- There is possibility of revenue generation in such cases.

Revenue Generation Model adopted by of Rajasthan

S.NO.	CONTENT	VALUE	UNIT
1	Dredging Project Duration	A	year
2	Total Likely silt deposition up to the end of dredging period	B	MCM
3	Efficiency for dredging considered	70	%
4	Targeted capacity to be reclaimed by dredging	C=70% of B	MCM
5	Av. Silt load to be dredged per annum	D=C/A	MCM
6	% of Sand in the depostion as per test results	E	
7	Estimated rate of dredging sand-silt & extraction of sand from mixture Rs / Cft	F	Rs/cft
8	Market rate of sand at river site (Rs/Cft)	G	Rs/cft
9	Profit available for sharing (Rs/cft)	H=E-G	Rs/cft
10	Considering Government share in total available profit (%)	I	%
11	Government share (Rs/cft)	J=I*H	Rs/cft
12	Estimated Revenue Share of ERCPC per year (Rs in crore)	R=J*D*E%*35.32/10	crore

Estimated Revenue by Rajasthan

- Work orders for all three reservoirs have been issued in Feb’23 and Mar’23.
- Following Revenue has been estimated to be received :

S No.	Name of Reservoir	Period of Dredging	Capacity to be reclaimed in MCM	Total Expected Revenue (Rs in Crore)
1	Bisalpur	20	95.84	2864
2	Som Kamla Amba	10	13.03	333
3	Gudha	10	26.64	157

Conclusion :

- Sedimentation rates has to be monitored regularly and if needed suitable Catchment area modifications should be done to prevent erosion and further siltation in water bodies.
- In Rivers basins sediments transport models can be developed for developing a scientific approach towards extraction of mineable sand on sustainable basis.
- The sediment extracted during desilting can be utilized for various purposes such as infrastructure development roads , filling and agricultural applications etc .
- Department has to conduct a market survey and has to give site specific methodologies for desilting/dredging .

Thanks