

# A brief overview of international practices on sediment management with beneficial reuse and their applicability to Tuyamuyun Hydro-Complex

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**TIPPING POINT**  
RESOURCES GROUP



A webinar on WEFE Nexus approach practical implementation in Central Asian countries



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# Presentation outline

## ➤ **Introduction**

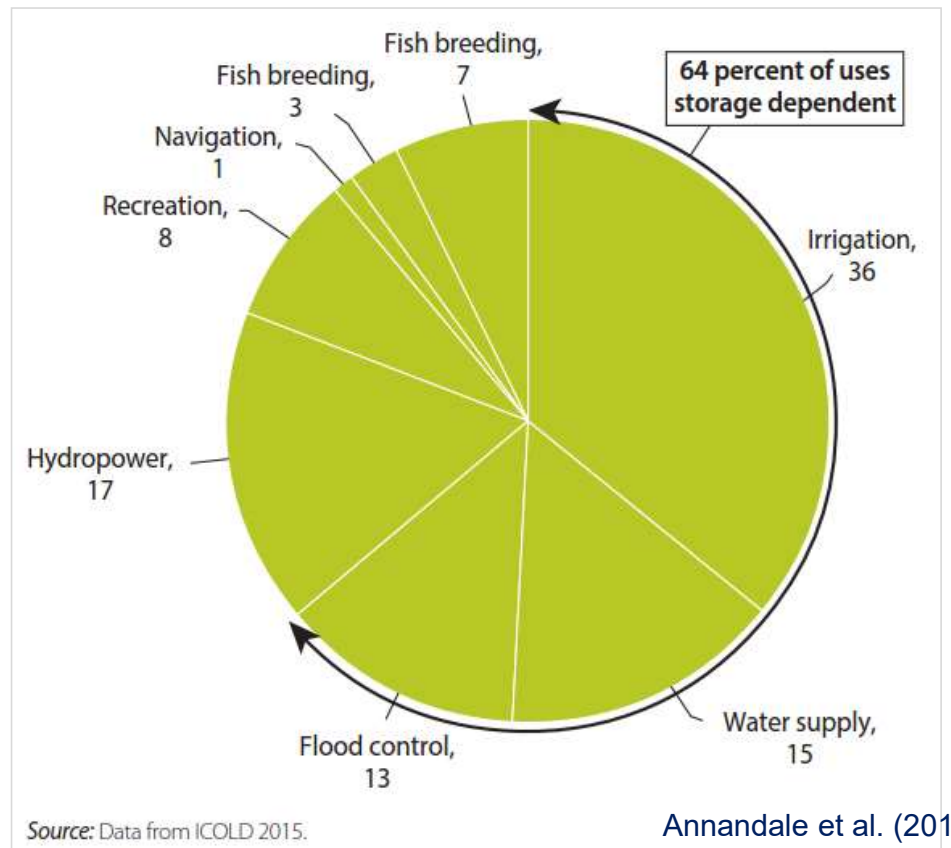
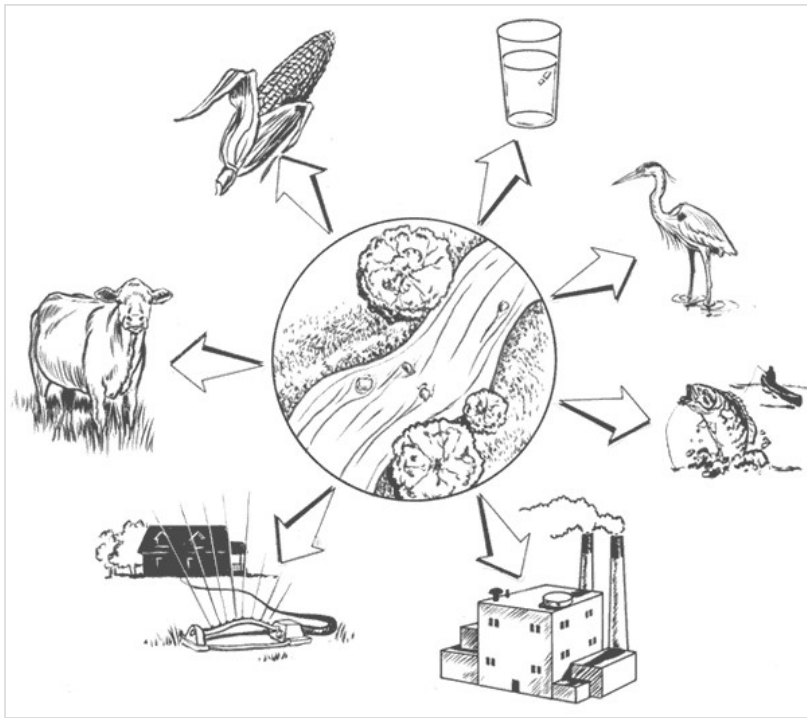
- ✓ Reservoirs and Water-Food-Energy-Environmental (WFEE) Nexus
- ✓ Reservoirs, Ecosystem Services and Sustainable Development Goals (SDGs)

## ➤ **Sediment management with beneficial reuse**

- ✓ General introduction and international practices
- ✓ Applicability of various practices to THC

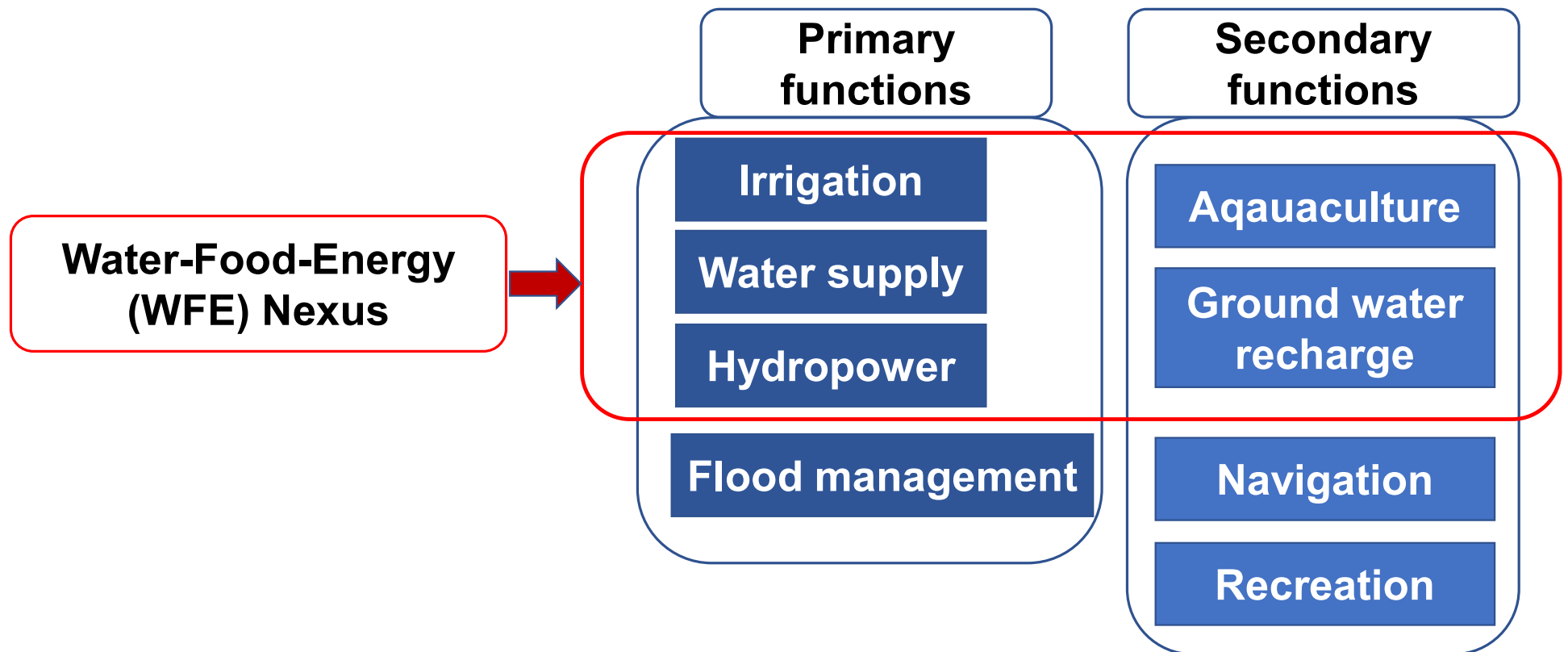
# Introduction

## Dams and reservoirs – an integral part of water resource and flood management



# Introduction

## Reservoirs and Water-Food-Energy Nexus



# Introduction

**WFE + Environment (WFEE) as an integral part of reservoir sustainability**

## Water-Food-Energy (WFE)

Agriculture  
Aquaculture  
Hydropower  
Water supply

**People  
(Social)**

## Ecosystem-Climate (EC)

Biodiversity and ecology  
Erosion and sedimentation  
Water quality  
CO2 emissions

**Planet  
(Environmental)**

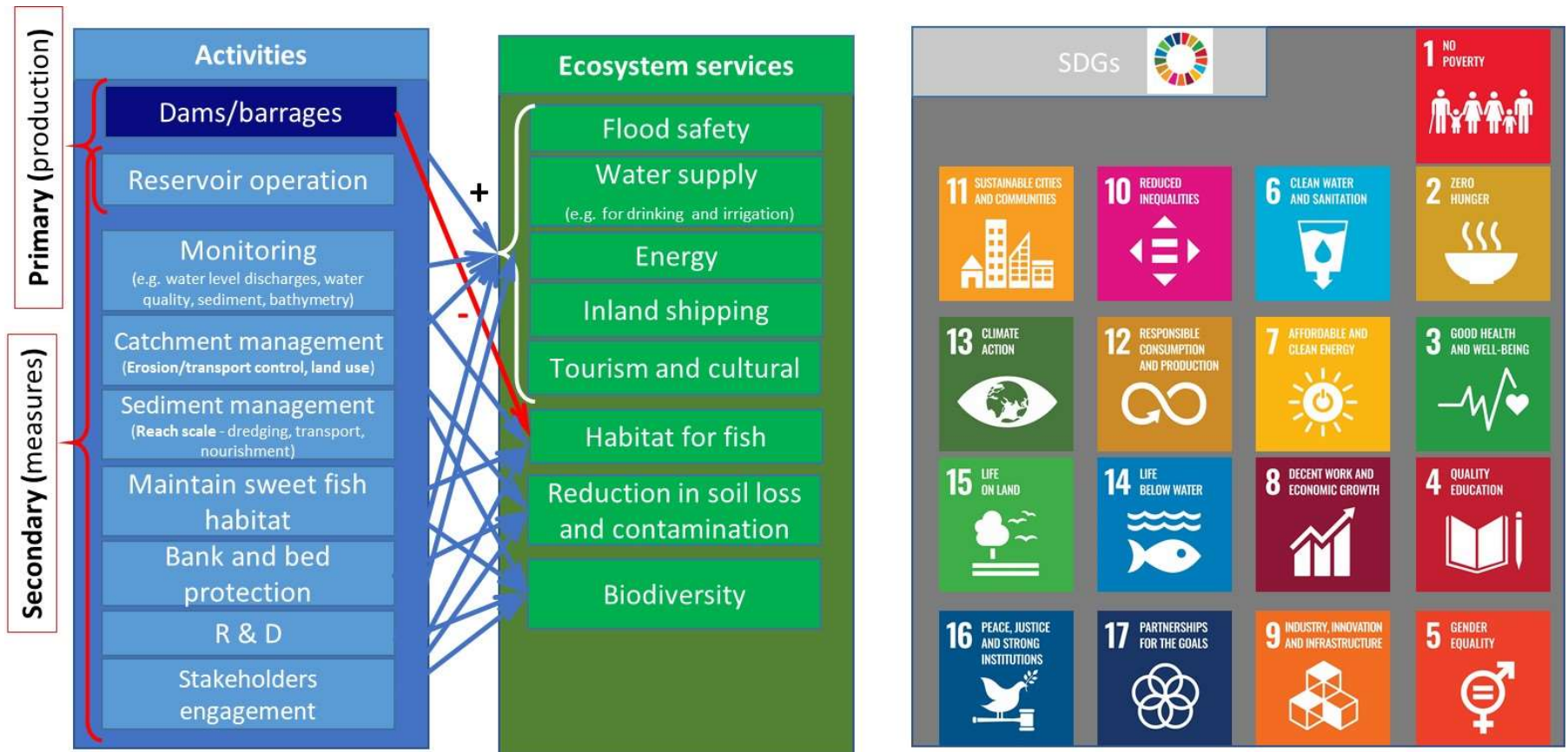
## Prosperity-Safety (PS)

Navigation  
Recreation and tourism  
Flood and land management  
Public health

**Prosperity  
(Economic)**

# Introduction

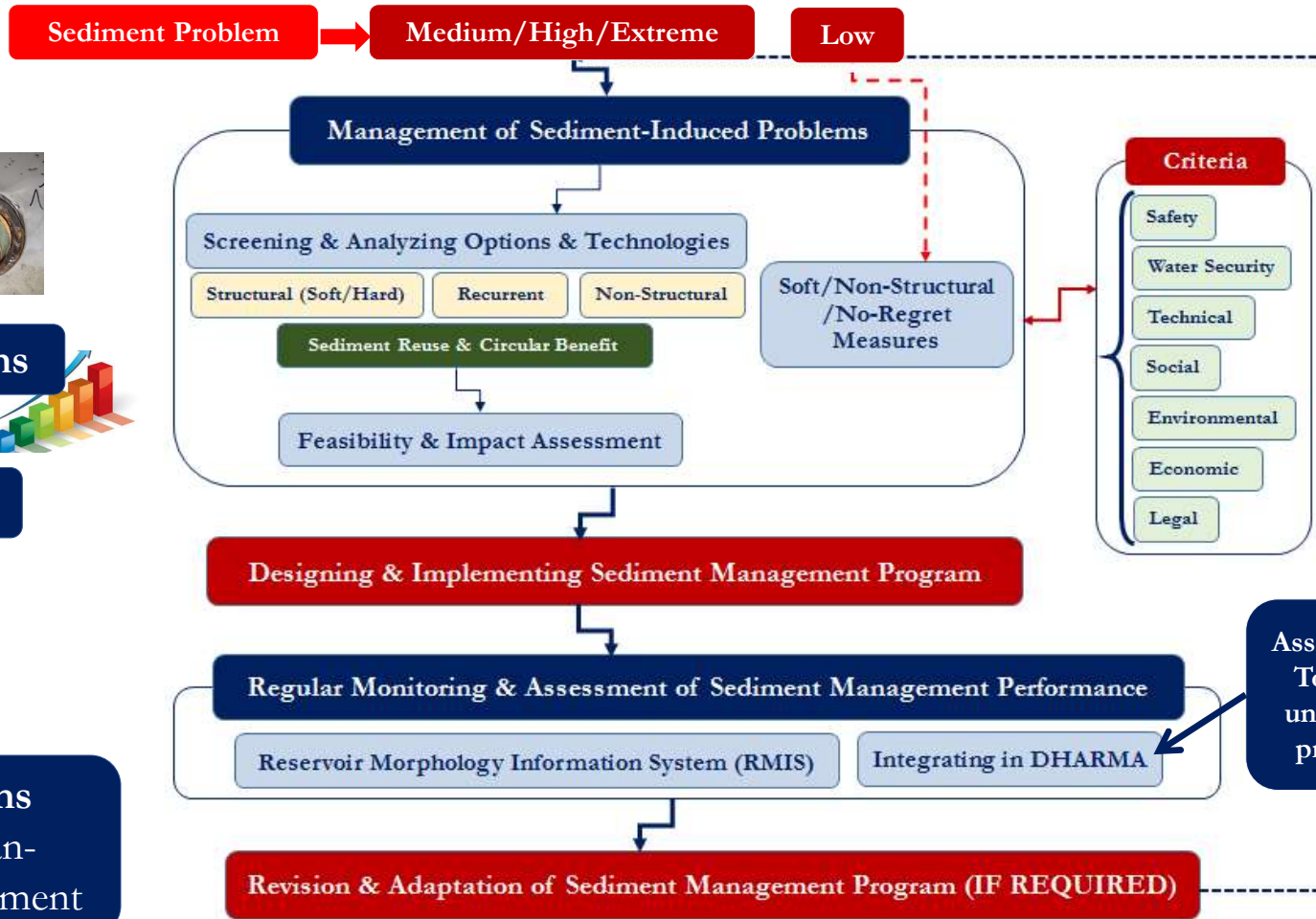
## Connection to Ecosystem Services (ES) and Sustainable Development Goals (SDGs)



# **Sediment management with beneficial reuse**

General introduction and existing practices

# Sediment management



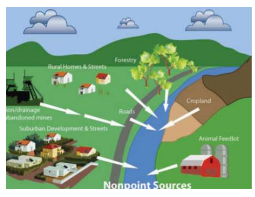
## Type of problems



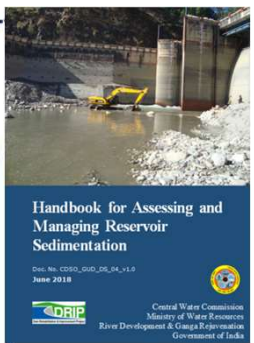
## Magnitude of problems



## Source of problems



**Reasons of problems**  
Natural or/and human-induced, e.g. mismanagement



Giri et al. (2019)

**Asset Management Tool, developed under dam safety project in India**



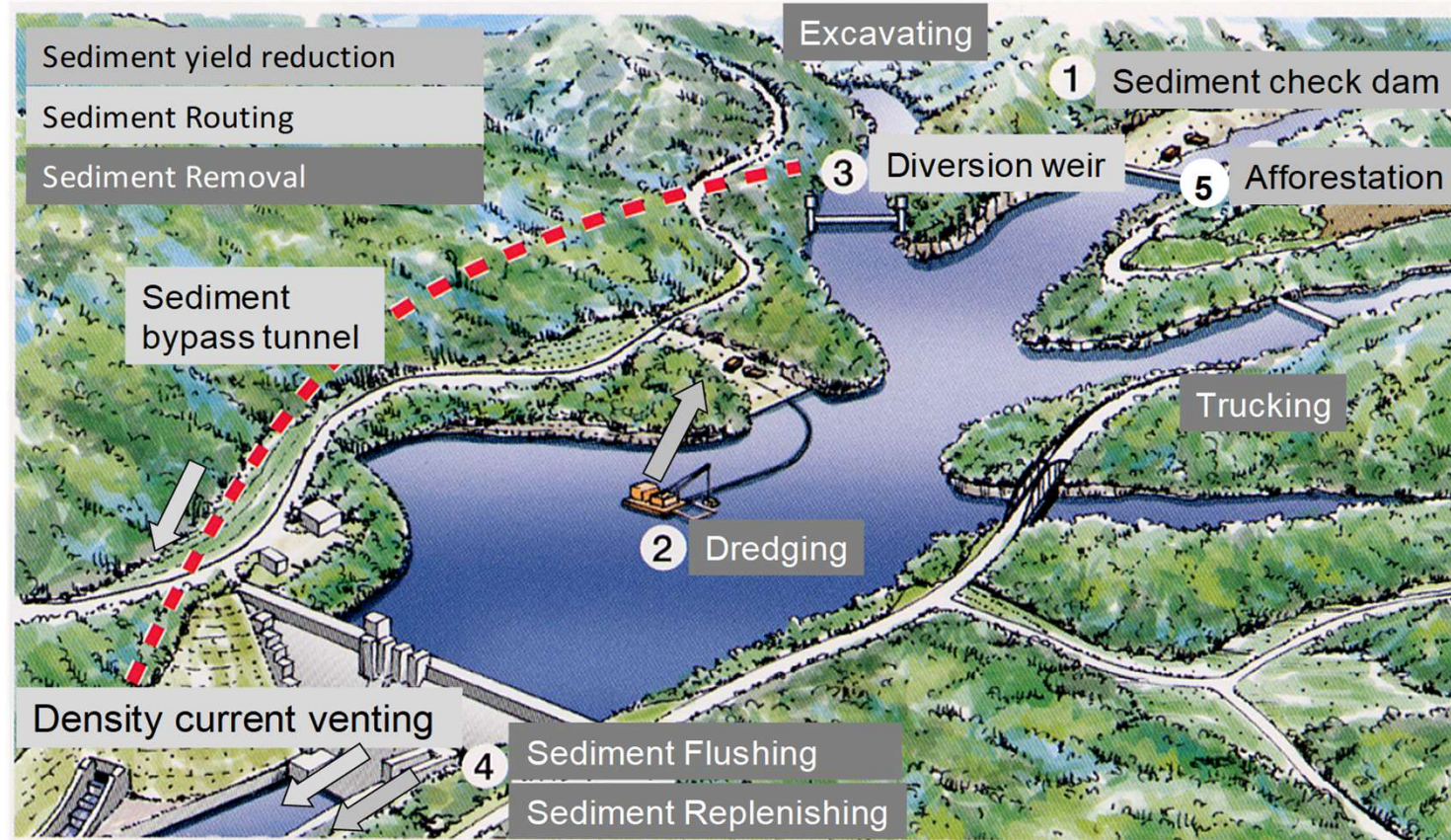
# Sediment management

## General practices

**Sediment yield reduction**  
(catchment/land-use/river management)

**Sediment routing**

**Sediment removal or redistribution**



Source: Japan paper

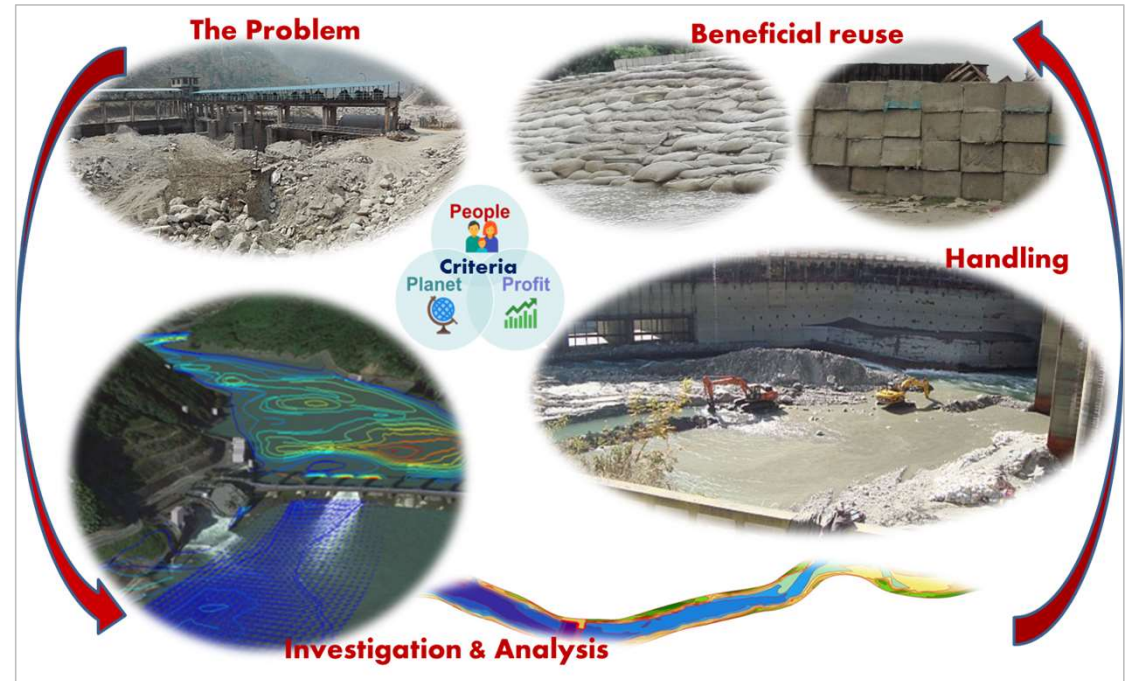
# Circular sediment management

## Sediment management considering beneficial reuse

Sediment is a resource and not the waste!

- Engineering uses
- Agricultural/product uses
- Environmental enhancement

Several challenges related to social, technical, environmental and legal aspects!



# Circular sediment management

## Practices on sediment reuse

**Sediment is a resource and not the waste!**

Country	Reused (% of total DM)	Remarks
Japan	90	Engineering uses (e.g. Construction of airport with DM stabilized with cement) and environmental enhancement e.g. Tidal Mudflats (DPC, 2009)
Spain	76	Used primarily for land reclamation and beach nourishment projects (Vidal, 2006)
USA	20-30	Uses include: habitat development; development of parks and recreational facilities; agricultural, forestry, and horticultural uses; strip-mine reclamation/solid waste management; shoreline construction; construction/industrial; and beach nourishment (USACE, 2007)
Netherlands	23	4% of this material is treated before reuse, 4% has a direct reuse and 15% is spread on land (Palumbo, 2007)
Ireland	20	Insignificant use of maintenance DM; 44% of capital DM reused (Sheehan et al., 2009)

Sheehan et al., 2009; Giri et al. (2019)

**Land reclamation, land filling**

**Topsoil enhancement and fertilizers for agricultural use, forestry**

**Construction materials/products, decorative landscaping products, filler for polymer composites**

**River management (bank protection, sandplugs, earthen dams, dikes etc.)**

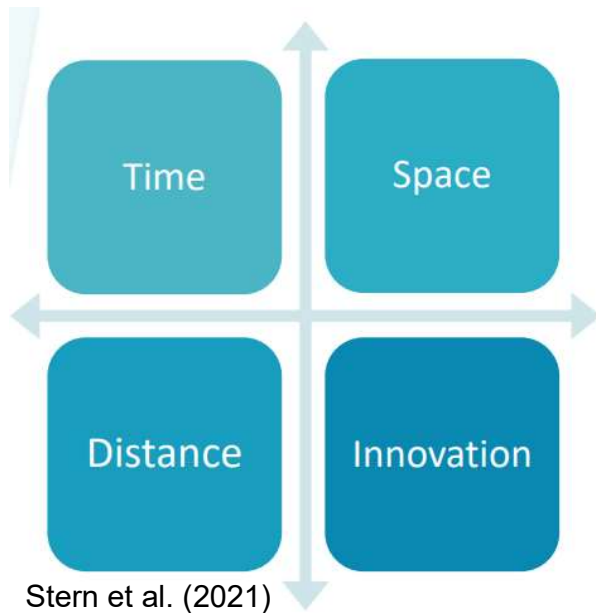
**Beach nourishment, shore protection**

**Habitat creation and restoration**

**Capping, filling for abandoned mines/quarries**

# Circular sediment management

## Challenges and constraints



**Time** - Duration, regulatory timeframe, permitting window, volume of accumulation

**Space** – Project-limited working site access or area to accommodate sediment processing, project logistics

**Distance** - Sediment disposal, beneficial use sites, transportation logistics, legal aspects

**Innovation** - “If you always do what you’ve always done, you will always get what you’ve always gotten”

**Social, technical, environmental, economic, and legal constraints!**

# Existing and planned practices

## Shihmen reservoir (Taiwan)

Existing and proposed sediment management measures in Shihmen reservoir and expected results of their implementation

Average annual sediment inflow (10 <sup>6</sup> m <sup>3</sup> )	Expected average annual sediment outflow						Sum
	PRO sluice way	Power plant penstock renovation	Dawanping silt sluice tunnel	Amuping sediment sluice tunnel	Dedging near dam	Dredging u/s from reservoir	
3.42	0.15 (4%)	1.02 (30%)	0.71 (21%)	0.64 (19%)	0.50 (15%)	0.40 (12%)	3.42
	55%			19%	26%		100%

Gated sediment sluice tunnels  
 • FEWS may help optimal gate operation



Real-time measurement of sediment concentration using Time Domain Reflectometry (TDR)

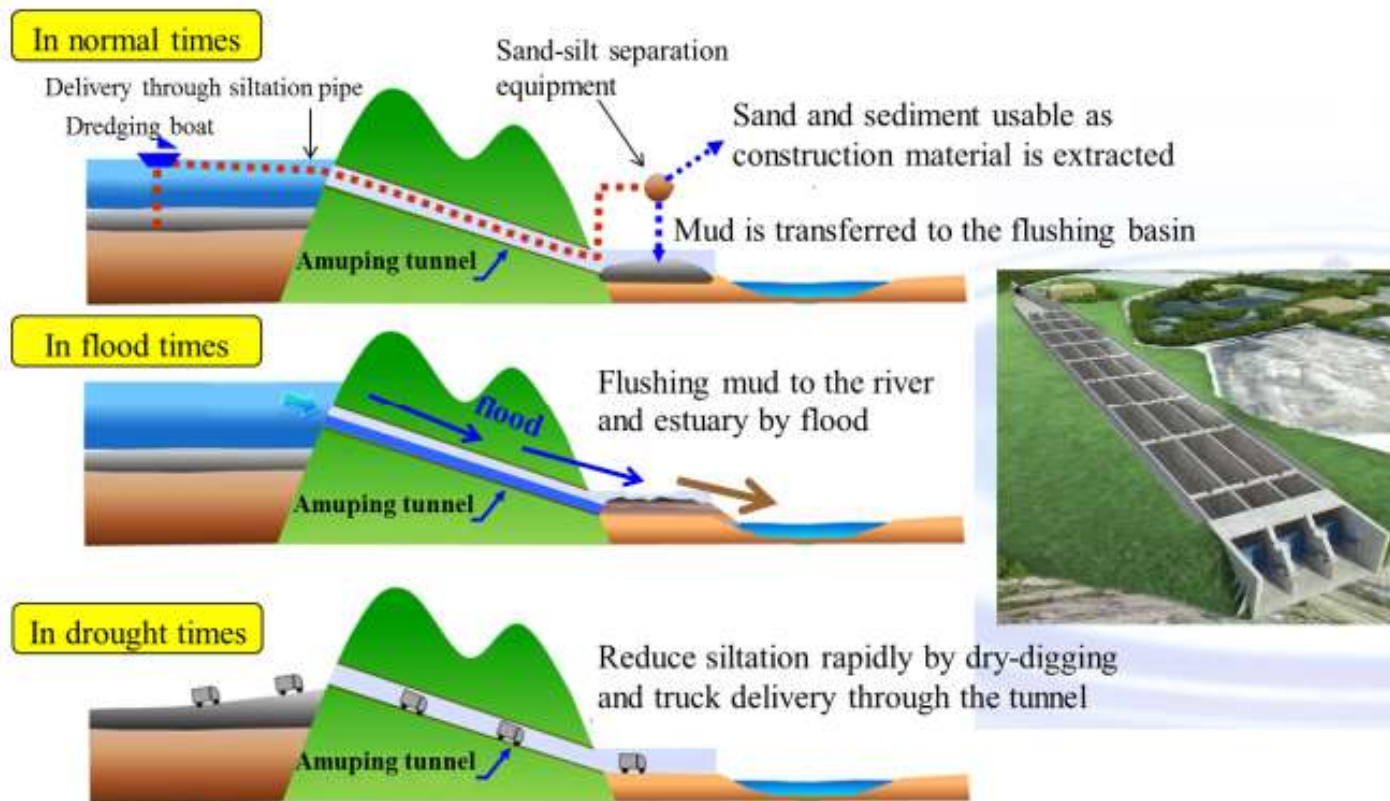


Chung and Lin (2011)

# Existing and planned practices

## Shihmen reservoir (Taiwan)

### Multifunctional desilting tunnel

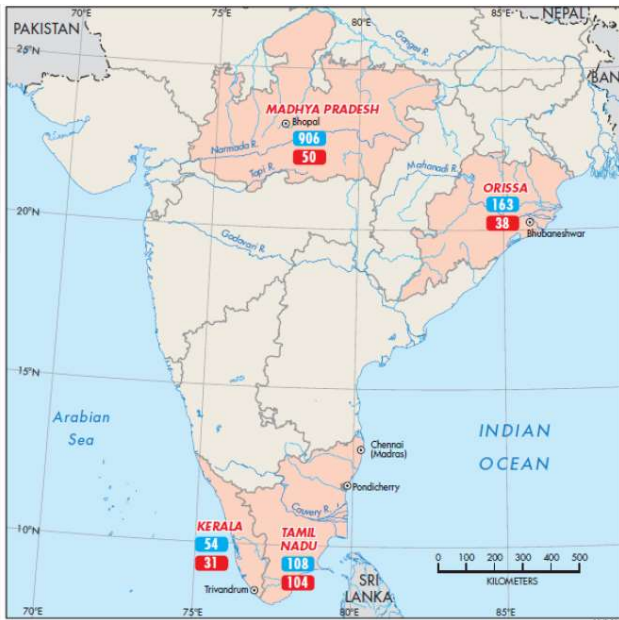


# Existing and planned practices

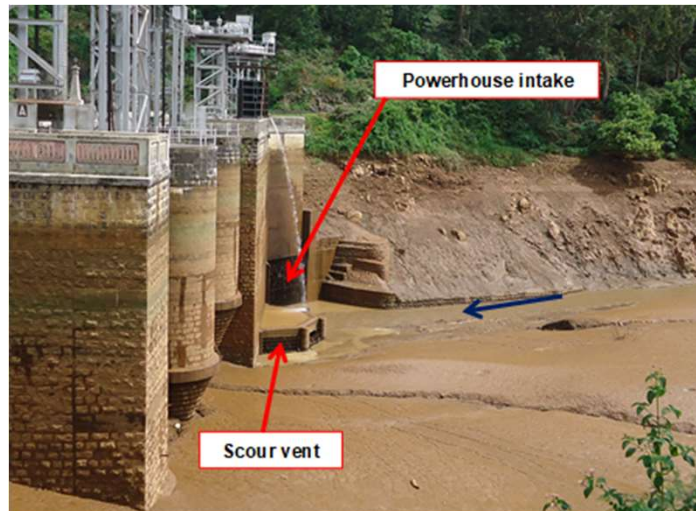
## Dam Rehabilitation and Improvement Program (India)

More than 5000 large dams in India

Rehabilitation of > 250 dams and reservoirs in 7 States



Kunda Palam (Tamil Nadu)



Pillur (Tamil Nadu)



Maneru Bhali – 1  
(Uttarakhand)



# Existing and planned practices

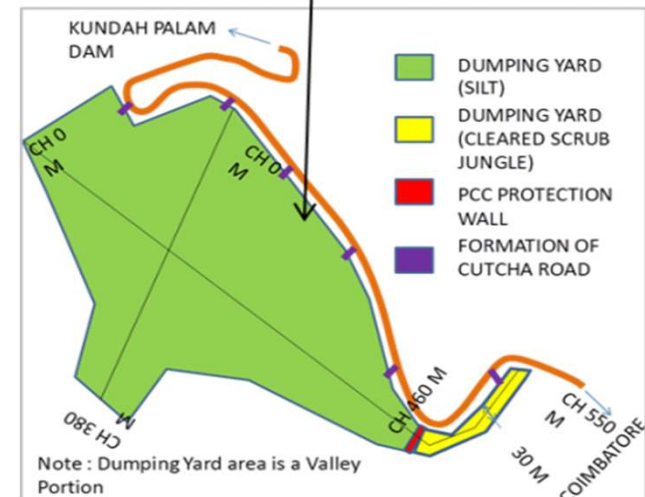
## Dam Rehabilitation and Improvement Program (India)

### Sediment management with removal and land filling

Sediment removal plan



Sediment reuse plan



Vegetated deposits at upstream of Reach I



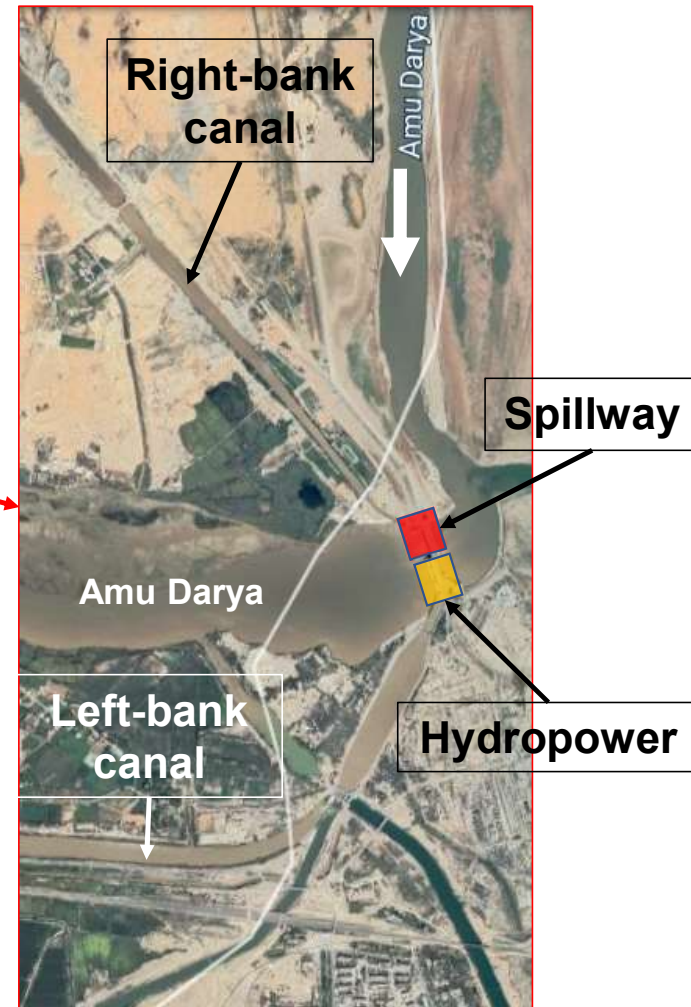
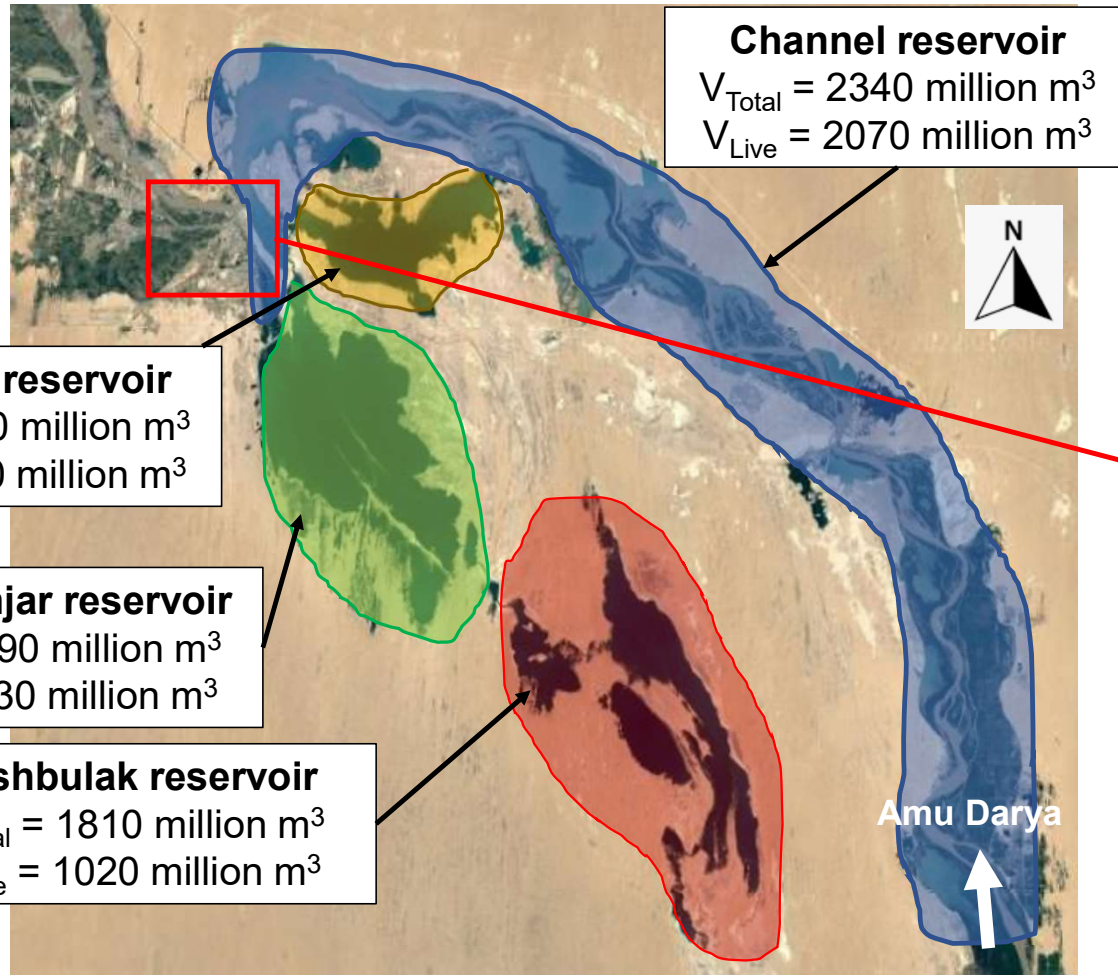
Deeper channel, approaching to tunnel intake (Reach III)





**Sediment management with beneficial reuse**  
Applicability of various practices to THC

# Characterization of the problems at THC



## Characterization of the problems at THC

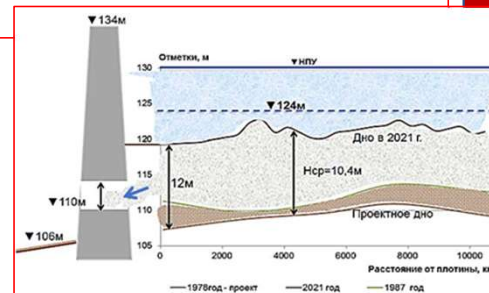
Significant sedimentation along the Channel reservoir, particularly within 50 km upstream of the dam leading to significant storage loss (about 63% of total storage)

Possible sedimentation problem in other reservoirs, i.e. Kaparas, Sultansandjar and Koshbulak (no quantitative information!)



**Affecting agricultural and drinking water supply**

Significant sedimentation in front of the dam leading to poor functioning of hydropower



**Affecting energy production**

# Management of sediment-induced problems at THC

## A first quick glance and propositions

### Structural, non-structural and recurrent measures

- ❑ **Sediment removal with beneficial reuse options (with a possibility of establishment of production unit/industries in the area)**
  - ✓ Topsoil enhancement for agricultural use (nearby Channel reservoir), fertilizer, afforestation
  - ✓ Construction materials/products
  - ✓ River management (bank protection, sandplugs, earthen dams, dikes etc.), river ecology, habitat creation and restoration
  - ✓ Downstream continuity and bypass (replenishment, sediment bypass tunnel/canal/new flushing channel etc.)



# Management of sediment-induced problems at THC

## A first quick glance and propositions

### Structural, non-structural and recurrent measures

- ❑ **Additional reservoir(s) to increase storage capacity**
  - ✓ Rehabilitation and extension of existing secondary reservoirs at THC
  - ✓ Construction of additional reservoir(s)
- ❑ **An integrated approach considering optimal use of water, efficient agricultural practices, minimizing water loss** (e.g. in irrigation canals) as well as **catchment/river/land-use management** in complement with establishment of proper **water+sediment information, forecasting and reservoir operation systems, rules and regulation**

**Social, technical, environmental and economic feasibility of proposed measure(s)**

**...to be continued...**

**Thank you!**