

Consideration on Extension of Operating Life of Dams by Removing Sediment

Takayama Dam (1969)



Shorenji Dam (1970)



Muro Dam (1974)



Nunome Dam (1992)



Hinachi Dam (1999)



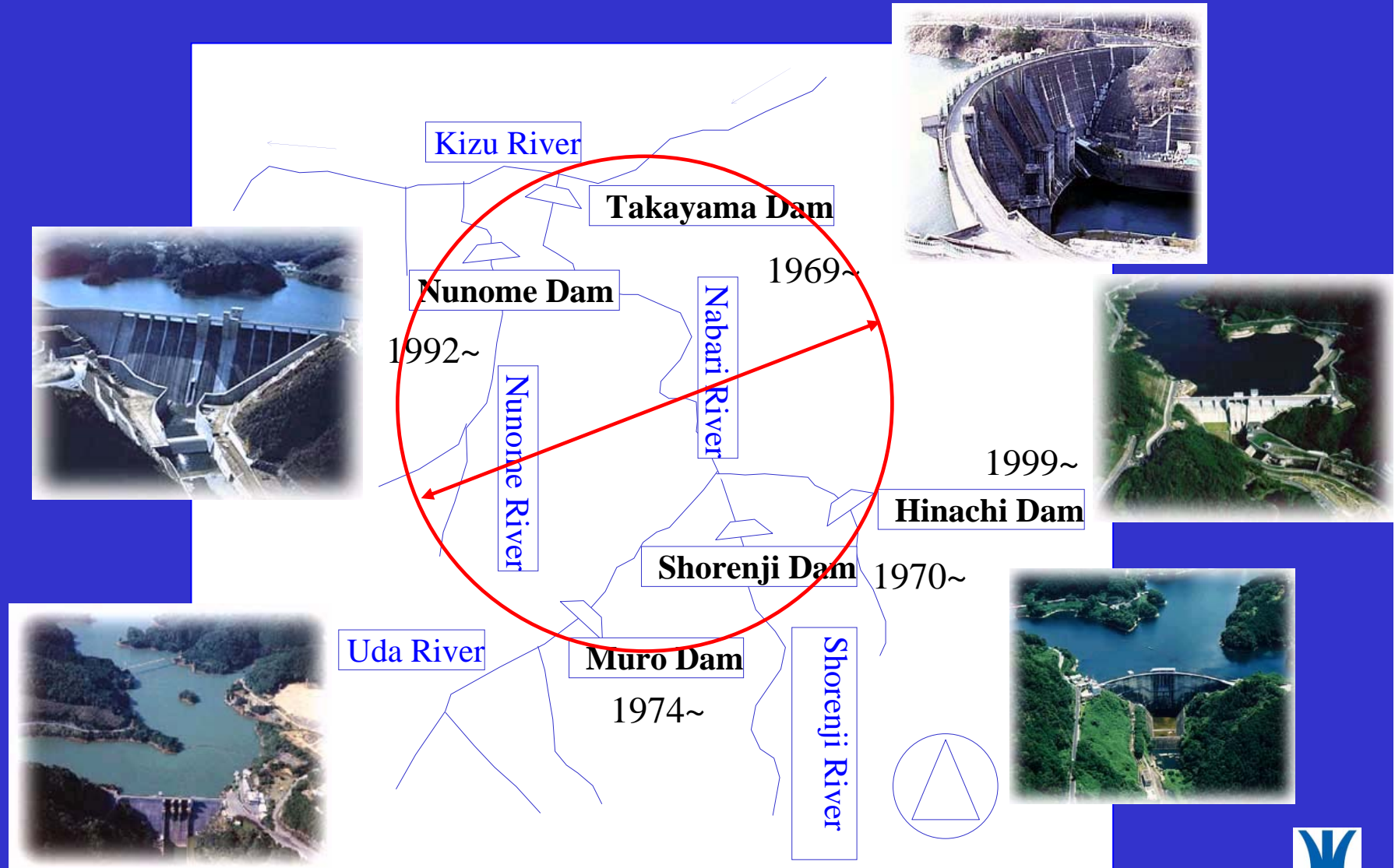
5 Dams
in Kizu River System



Location of 5 dams in Kizu River System



Position of 5 dams in Kizu River System



Flowchart of consideration

Arrangement of consideration conditions

- 1) Setup of management goal of reservoir function
- 2) Arrangement for countermeasure items of sediment
- 3) Setup of evaluation method for economic efficiency



Consideration of application to the group of dams in Kizu River System

- 4) Comprehension of sediment characteristics in the reservoir
- 5) Case study in Takayama Dam
- 6) Selection of countermeasure method which is the most economical in each dam
- 7) Consideration of operating possibility for the group of dams

Arrangement for countermeasures of sediment

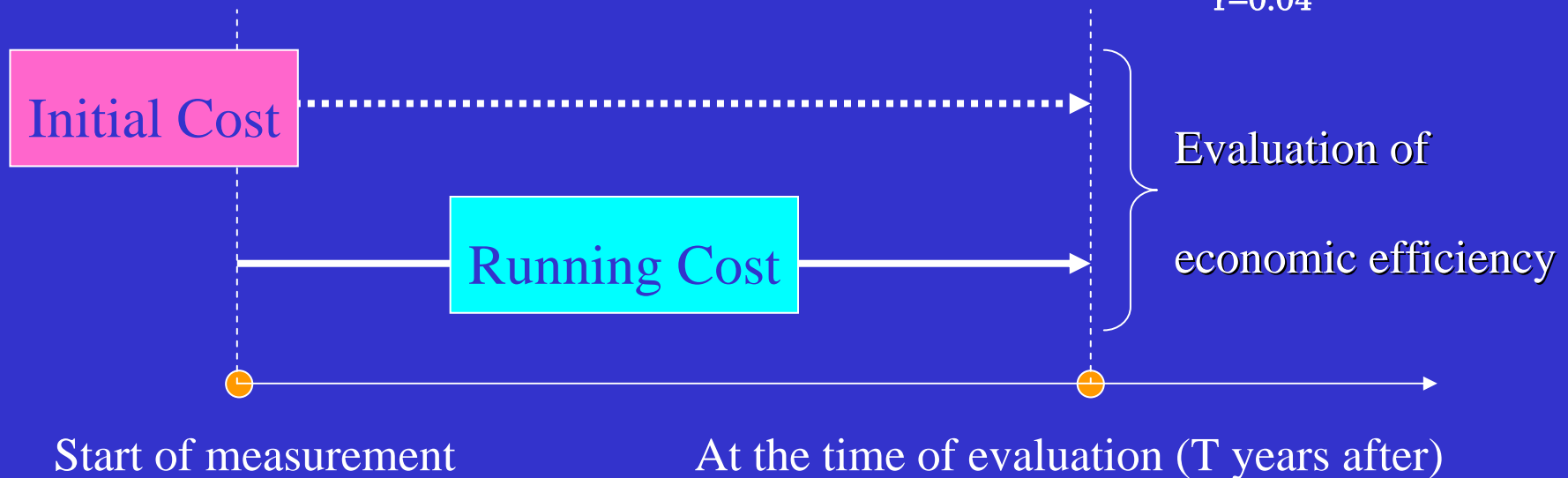
options	Description and the cost
excavation	Removing soil-storing area (more than NWL) in reservoir by machine Initial cost : none Cost : excavation
dredging	Removing sediment settled under water by dredger Initial cost : none Cost : excavation
Check dam (+excavation)	Construction of check dam and removing sediment in check dam by machine Initial cost : construction of check dam Cost : excavation at check dam
Flushing	Sediment flushing by temporary lowering water level of reservoir Initial cost : Installation for sediment flushing gate Cost : Rehabilitation of facilities
Bypass tunnel	Sediment are diverted directly downriver through the bypass tunnel Initial cost : Construction for bypass tunnel Cost : Rehabilitation of tunnel
Dry excavation	Periodical reservoir reducing water level to excavation and removing sediment Initial cost : none (Installation of a drawdown gate if necessary) Cost : excavation, payment for compensation reduced power energy, loss of storage volume

Conditions for consideration

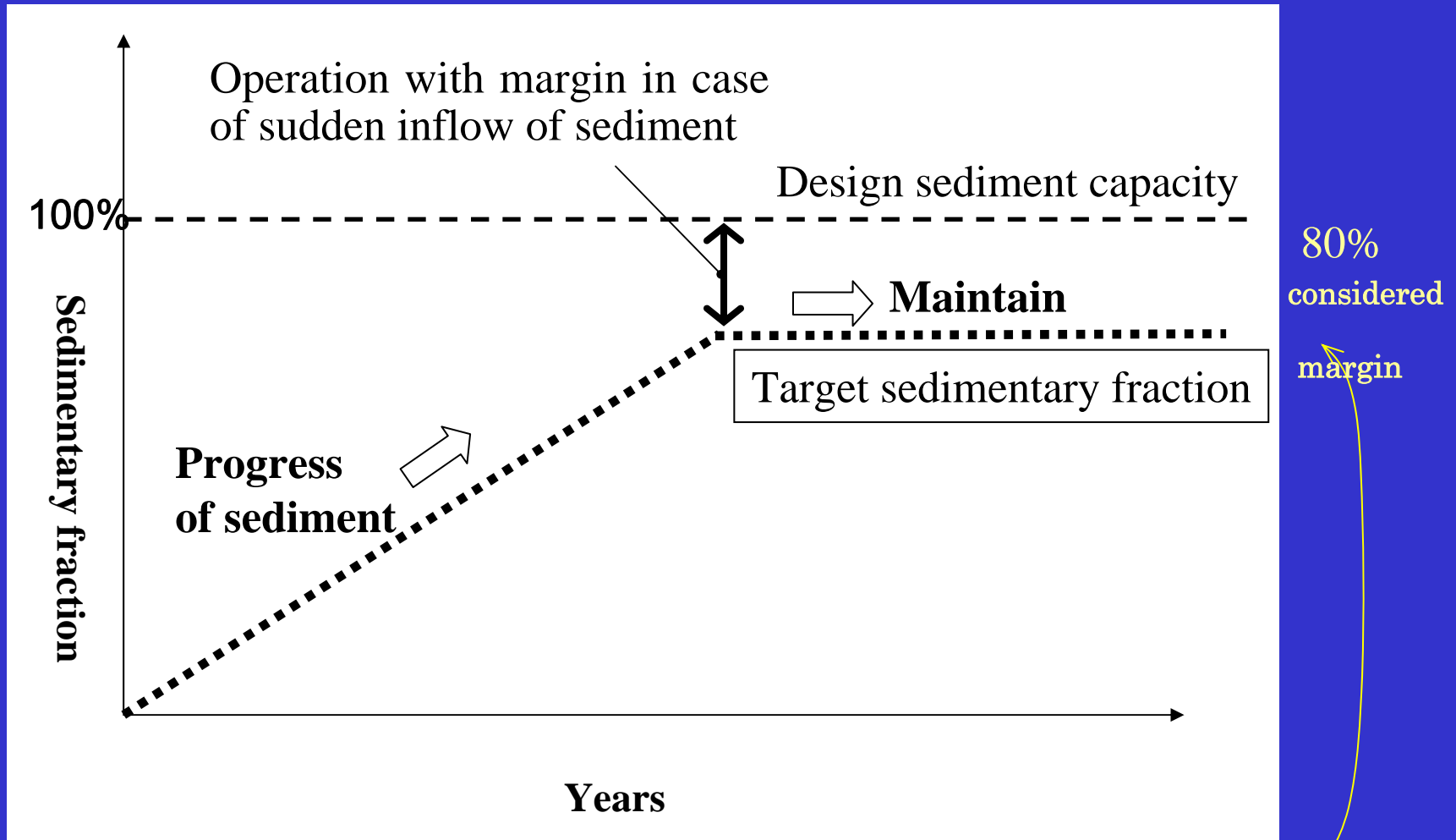
Evaluation method for economic efficiency

$$\text{Total Cost in } T \text{ years} = \sum_{t=1}^T \frac{\text{Cost for the } T\text{th year}}{(1+r)^T}$$

$r=0.04$



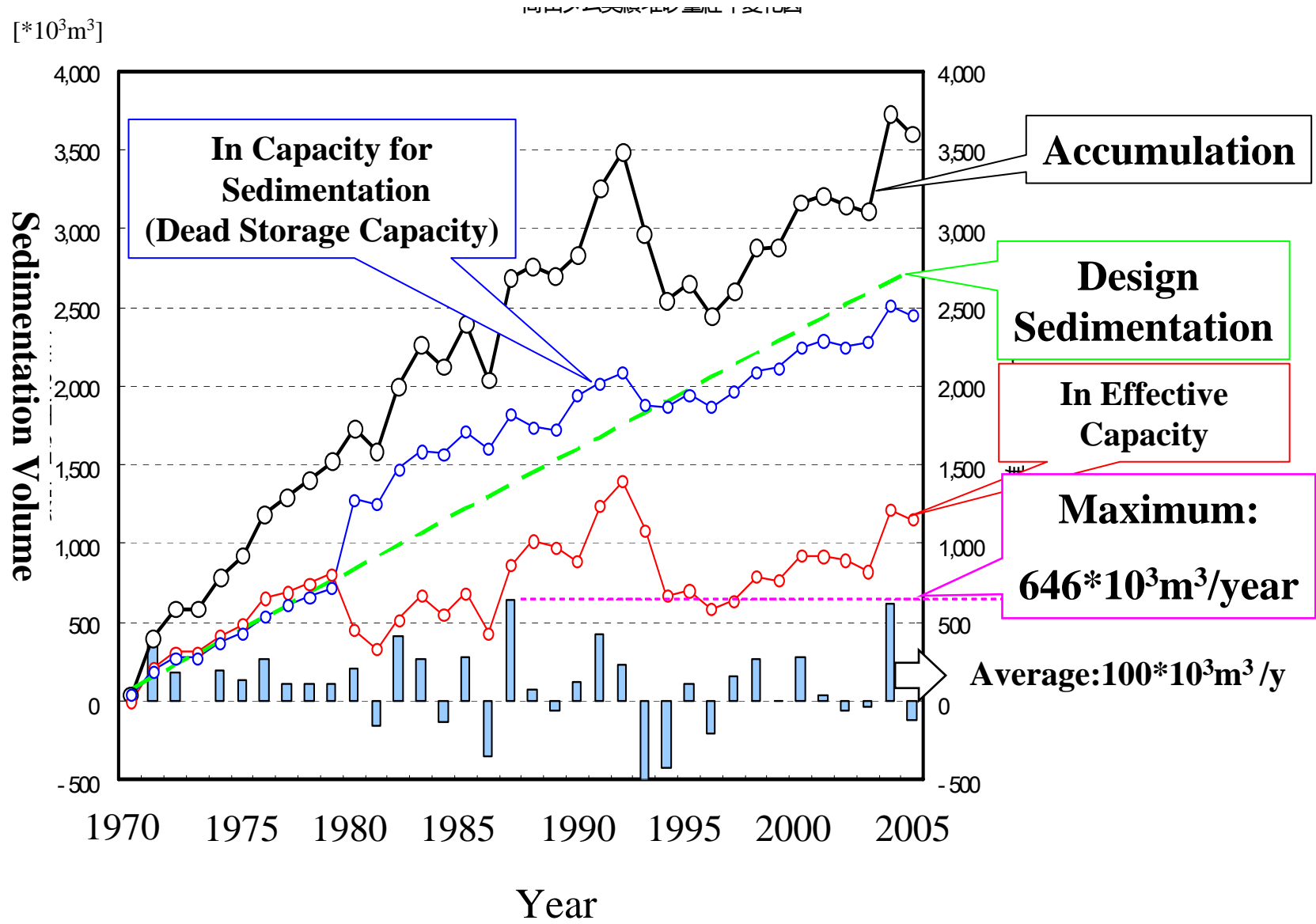
Concept of target sedimentary fraction



The largest inflow for one year into 5 dams
in Kizu River System: 10~15%



Annual variation of the amount of sediment in case of Takayama Dam



Sedimentation rate in the group of dams in Kizu River System (up to 2005)

	Years	Design Sedimentation Rate (m ³ /km ² /year)	Actual Average Sedimentation Rate (m ³ /km ² /year)	Sedimentation Fraction* (2005)
Takayama Dam	36	201	< 264	47.4%
Shorenji Dam	35	340	> 295	30.4%
Muro Dam	31	191	< 275	44.6%
Nunome Dam	13	253	< 278	16.5%
Hinachi Dam	6	318	< 613	15.4%

* In portion to Design Sedimentation

More sediment except Shorenji Dam



Characteristics of group of dams in Kizu River System

- So far, sediment problems have not been actualized yet.
(The situation is different from one in Chubu Region in Japan)
 - However, we need strategies for extension of operation life of dams now.
 - Kizu River System has a group of 5 dams
 - From the viewpoint of river environment, it is expected that sediment should be provided for downstream of the dams
- We find direction using as easy method as possible without detailed simulation of sedimentation



Inflow sediment to each dam classified by grain size

Name of dam	Average Inflow Sediment (m ³ /year)	Portion classified by grain size (%)		
		Wash Load (less than 0.075mm)	Sand	Sandy Gravel (more than 2.0mm)
Takayama	104,550	44.7	51.1	4.2
Shorenji	41,740	69.7	27.3	3.0
Muro	45,510	68.3	31.3	0.4
Nunome	23,550	65.4	33.9	0.7
Hinachi	56,810	64.7	35.0	0.3

(Past consideration in Yodo River)¹¹



Setup of the cost

Example in Takayama Dam

	Initial Cost	Running Cost
Excavation	-	2,500yen/m ³
Dredging	-	20,000yen/m ³
Check dam (including excavation)	5.4 bil. yen (check dam)	2,500yen/m ³
Flushing	10.1 bil. yen (gate for sediment flushing)	22 mil. yen/year
Bypass for sediment flushing	13.2 bil. yen (bypass for sediment flushing)	121 mil. yen/year
Reducing water level and excavation	-	2,500yen/m ³ (excavation) 75 mil.yen/year (compensation for reducing water level)

Assuming compensation for reducing water level to compare economically 12



Consideration results of combination to maintain function (Compared by annual average)

Example in Takayama Dam

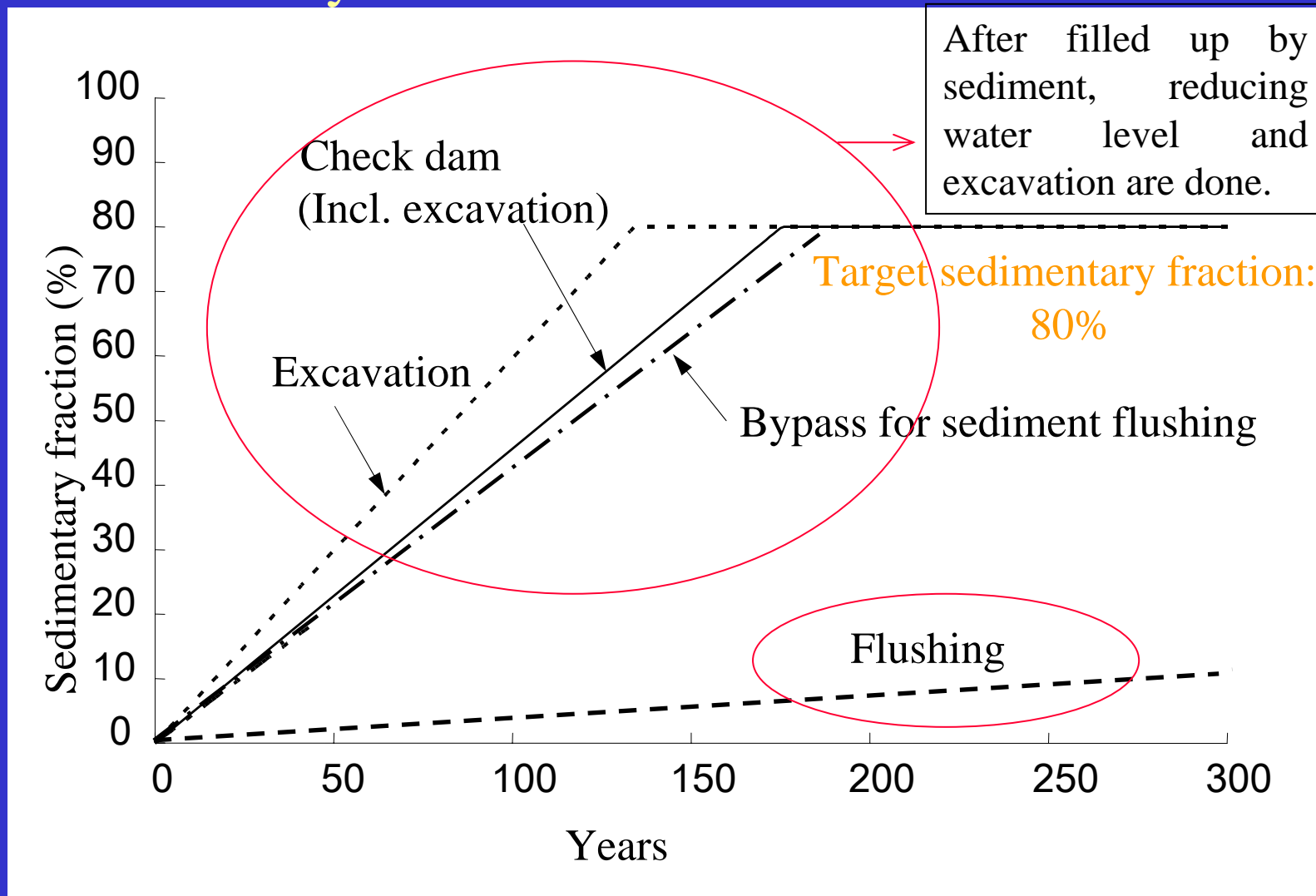
	Removed sediment volume (m ³ /year)	Non-removed sediment volume (m ³ /year)	Combined Annual Cost (mil. yen)	
			Dredging	Reducing water level
Check dam (incl. excavation)	69,889	34,661	693	162
Excavating	59,213	45,337	907	189
Bypass for sediment flushing	72,838	31,712	634	155
Flushing	102,350	2,200	44	81

Advantageous

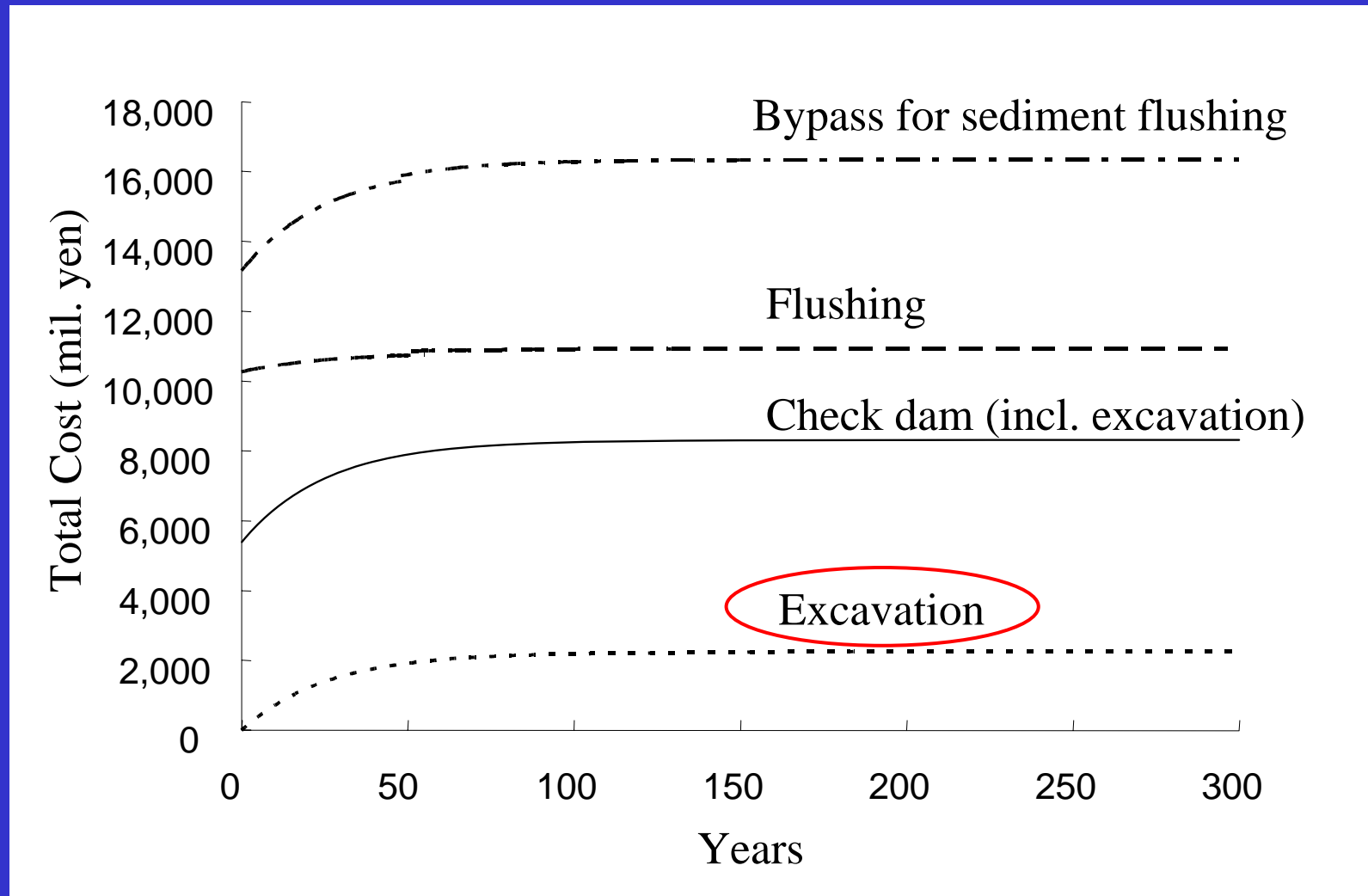
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Variation prediction of sedimentary fraction in Takayama Dam in each countermeasure



Total cost in each countermeasure in Takayama Dam



**Operation by excavation & reducing water level
and excavation → Most Economical**



Constraint conditions of reducing water level and excavation

- Is disposal of removed sediment possible?
- Is compensation for reducing water level possible?
 - Can't the group of dams back up?



A case of extension of operating life by excavating (returning sediment to the downstream of Takayama Dam)

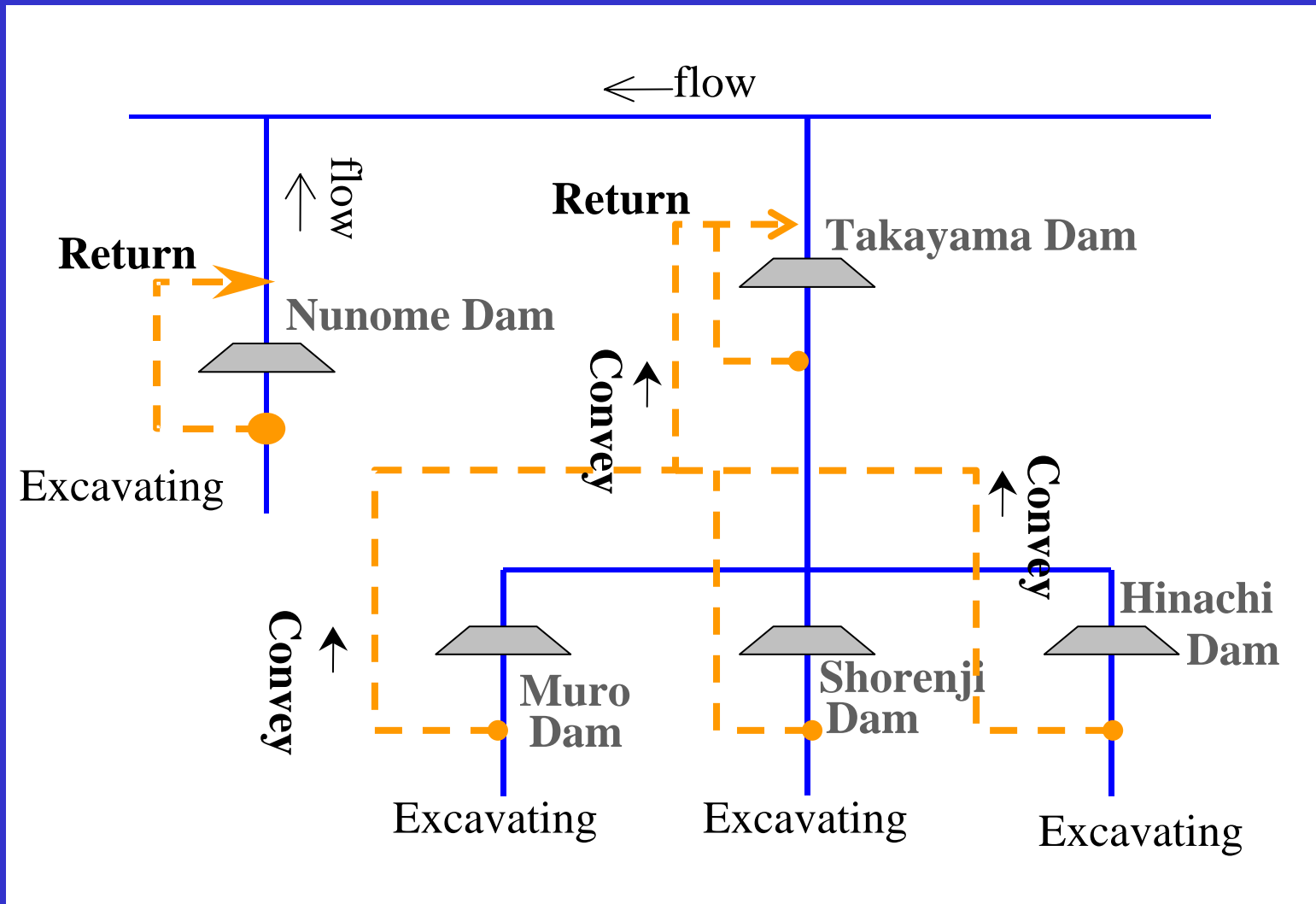
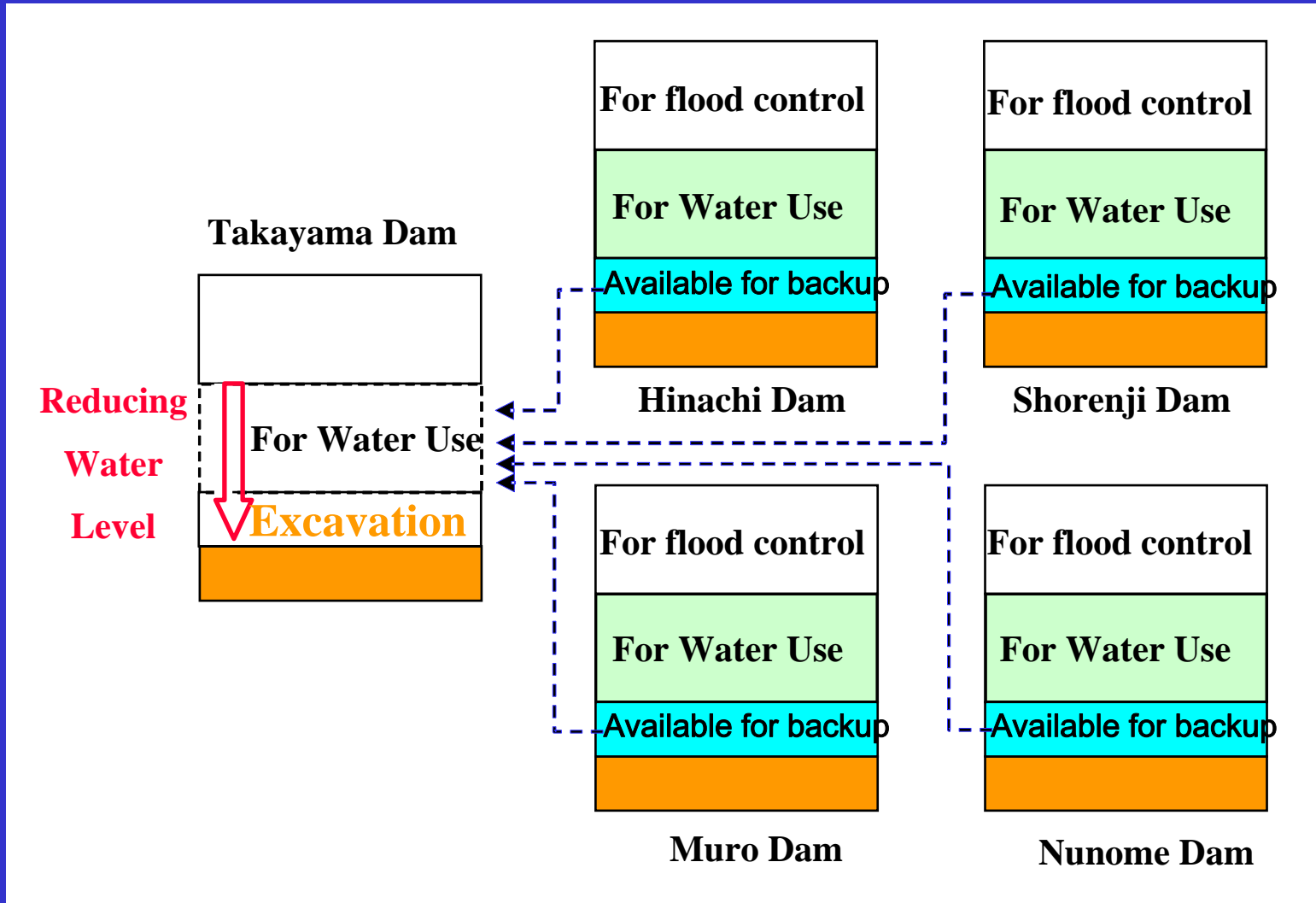


Image of collaborative operation of dams (A case of reducing water level in Takayama Dam)



Thank you very much for your attention.



**5 Dams
in Kizu River System**

