

Consideration on Extension of Operating Life of Dams by Removing Sediment

Takayama Dam (1969)



Shorenji Dam (1970)



Muro Dam (1974)



Nunome Dam (1992)



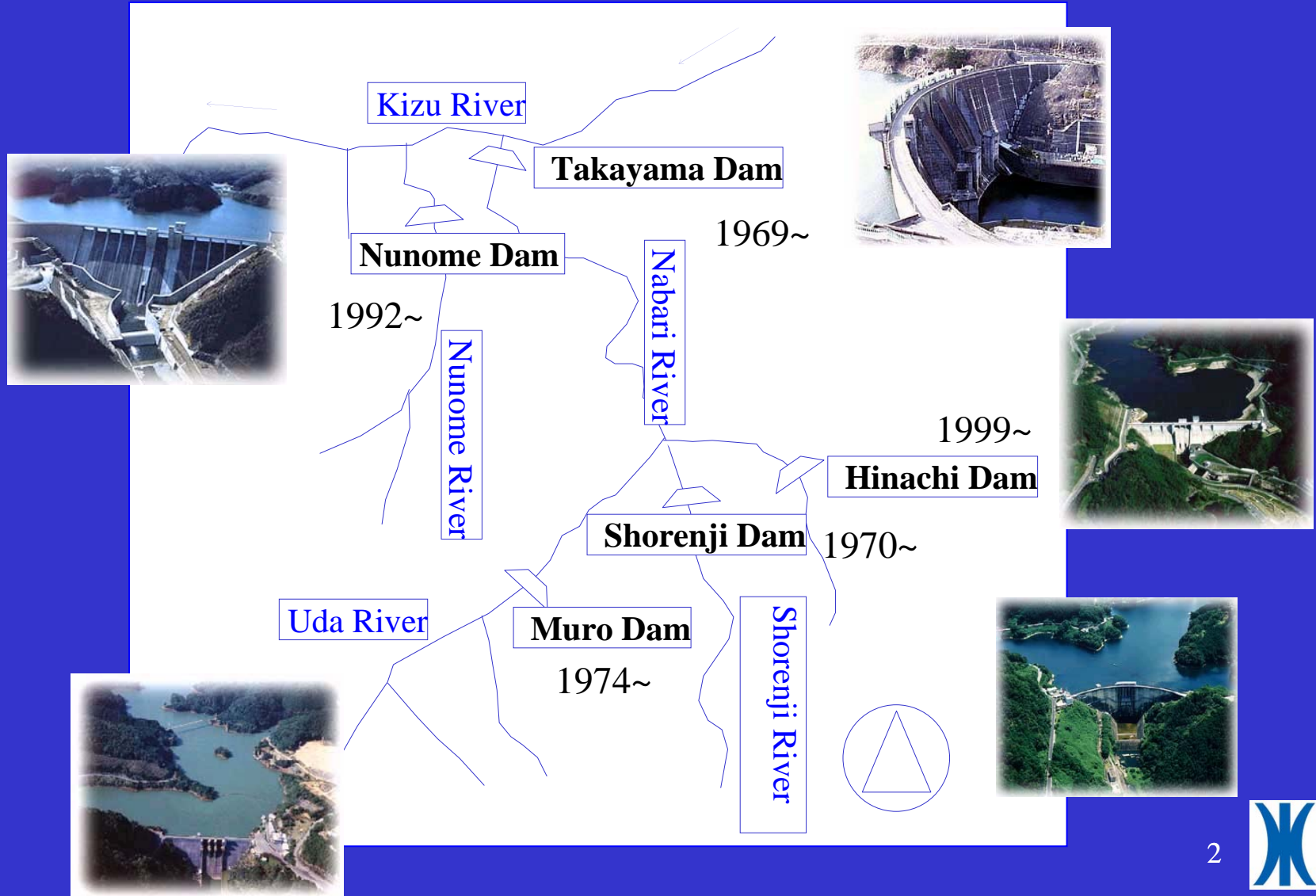
Hinachi Dam (1999)



5 Dams
in Kizu River System



5 dams in Kizu River System operated and maintained by Japan Water Agency



Flowchart of consideration

Arrangement of consideration conditions

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



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

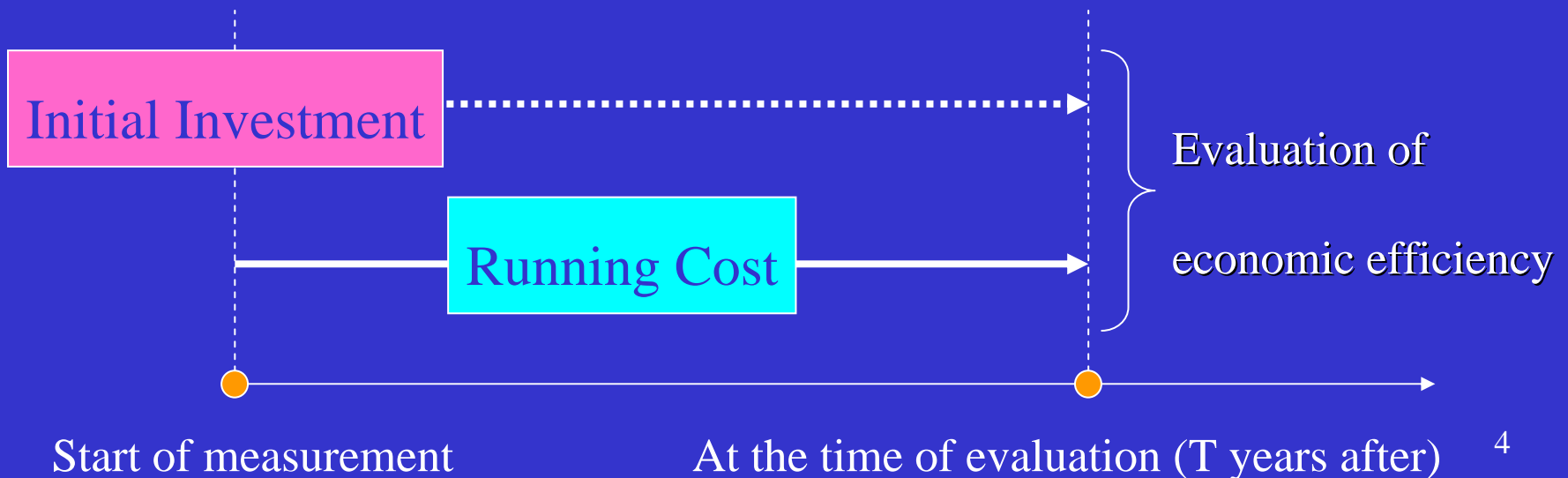
- 4) Comprehension of sediment characteristics in the reservoir
- 5) Case study in Takayama Dam
- 6) Selection of countermeasure method which is the most economical in each dam
- 7) Consideration of operating possibility for the group of dams

Conditions for consideration

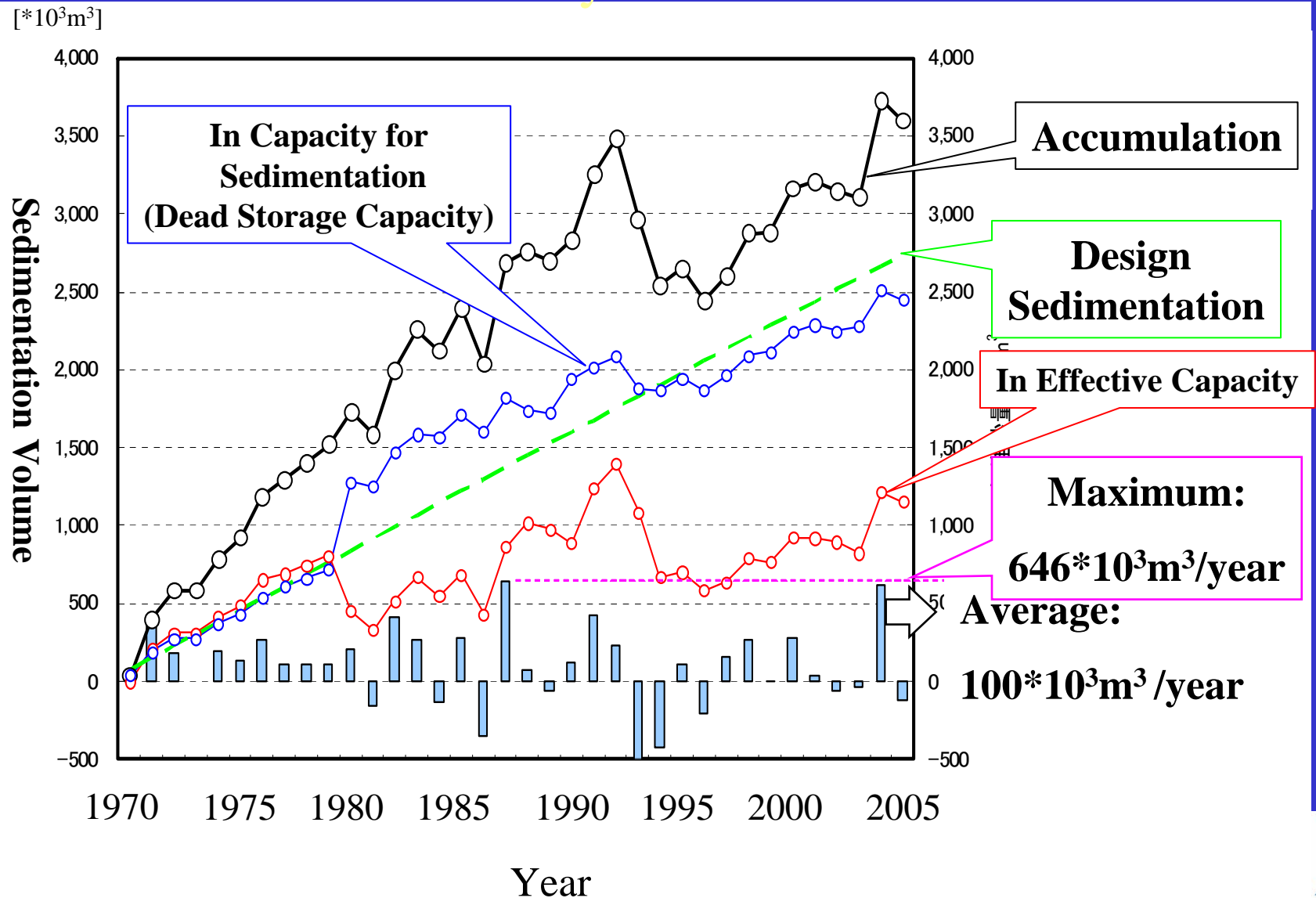
Evaluation method for economic efficiency (the total cost in 300 years)

Conversion to present value shall be done (discount rate: 4%):

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



Annual variation of the amount of sediment in Takayama Dam



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

About a half of the capacity

	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 discuss 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) ⁸



Setup of 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 9



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

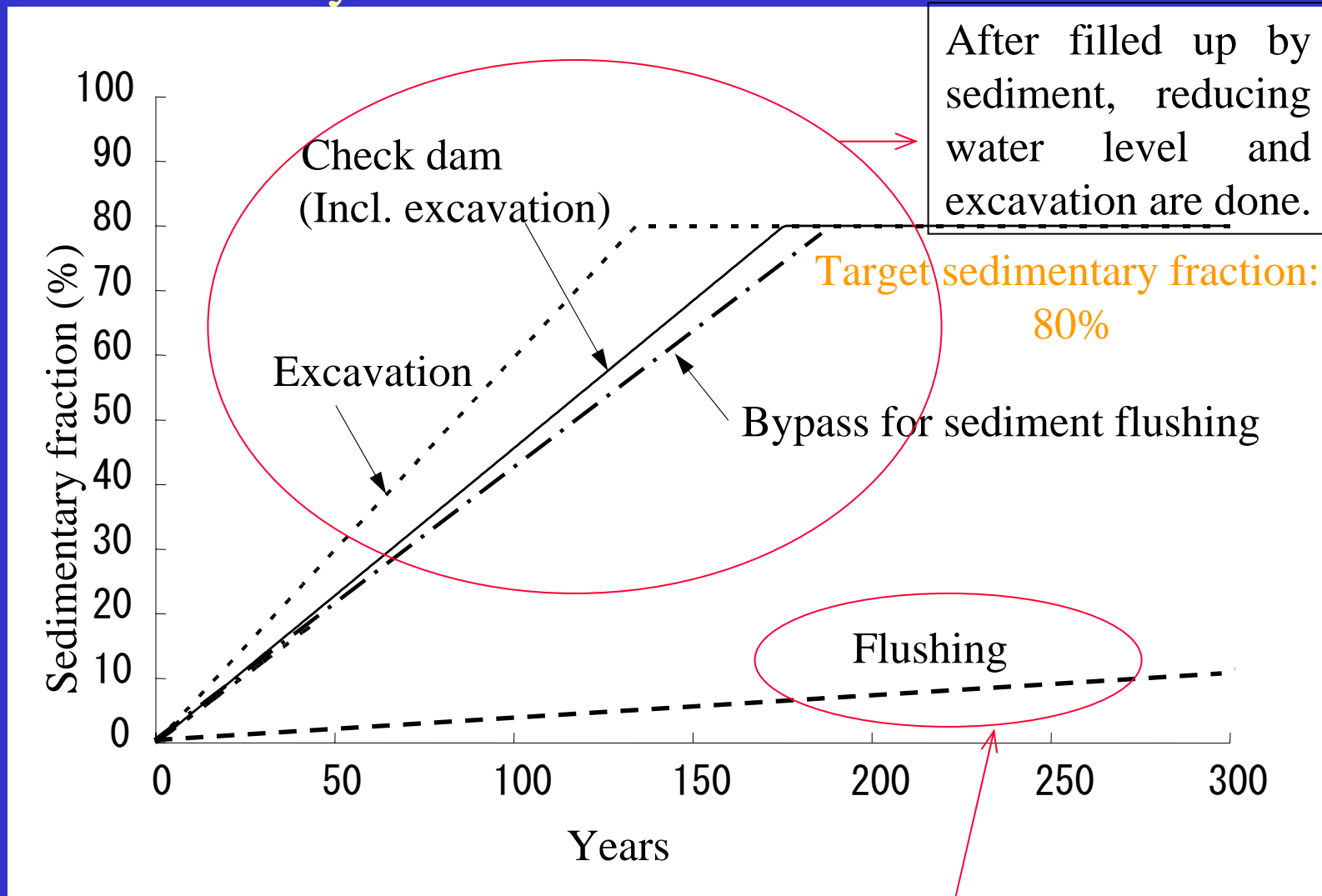
Example in Takayama Dam

	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



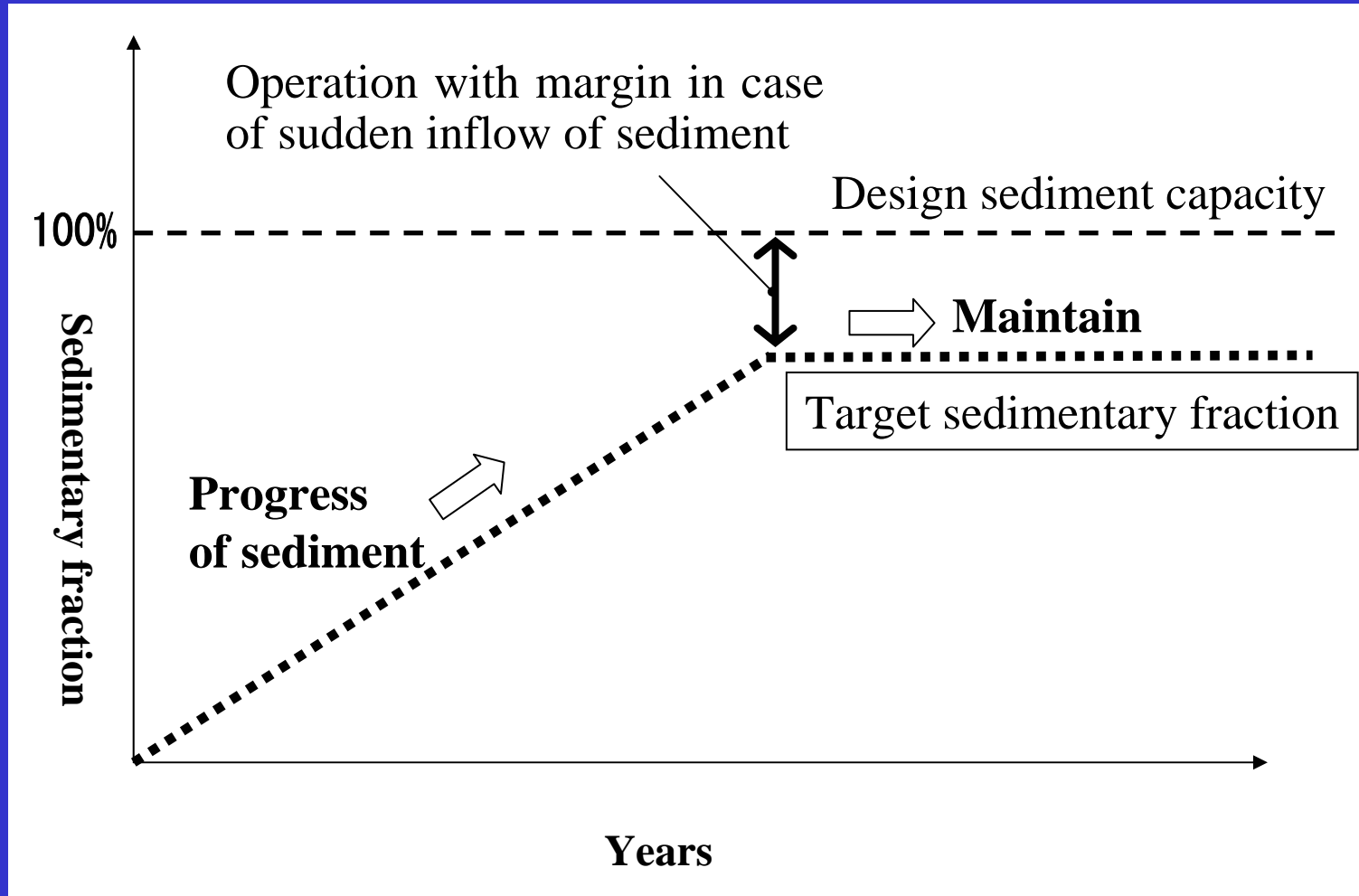
Variation prediction of sedimentary fraction in Takayama Dam in each countermeasure



Most effective because both wash load and sand are removed wholly



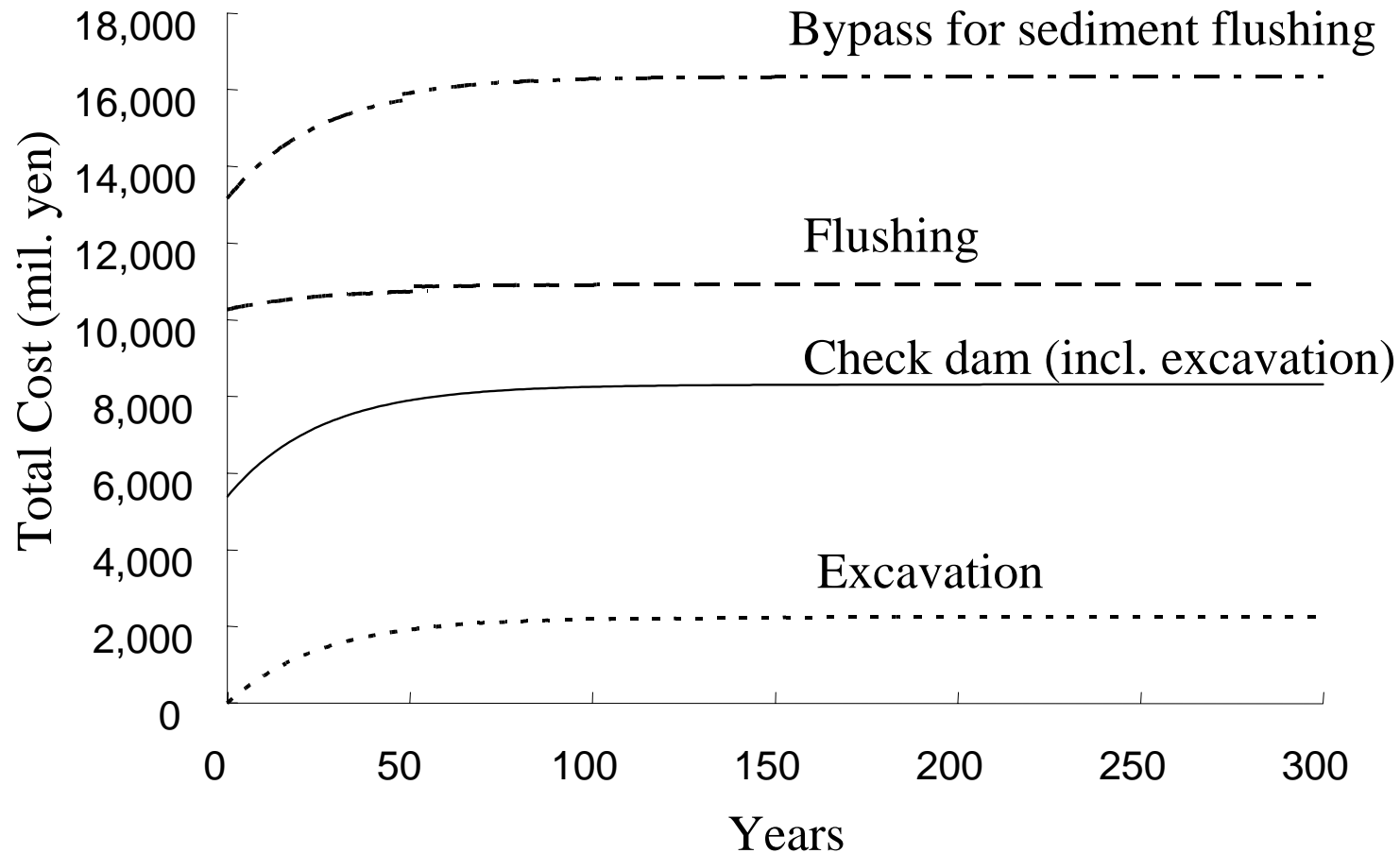
Concept of target sedimentary fraction



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



Total cost in each countermeasure in Takayama Dam



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



Comparison of total costs in 300 years of countermeasures applied to the group of dams in Kizu River System

(million yen)

Item	Combination	Takayama Dam	Shorenji Dam	Muro Dam	Nunome Dam	Hinachi Dam
Check Dam (incl. excavation)	Reducing Water level	8,307	4,070	3,232	2,179	2,840
Excavation	Ditto	2,259	617	652	356	865
Bypass for sediment flushing	Ditto	16,190	24,111	29,769	20,226	18,765
Flushing	Dredging	10,625	10,625	10,575	10,575	10,625

Comparison of total costs in 300 years of countermeasures applied to the group of dams in Kizu River System

<Assuming that sediment inflow is 4 times as much as now>

(million yen)

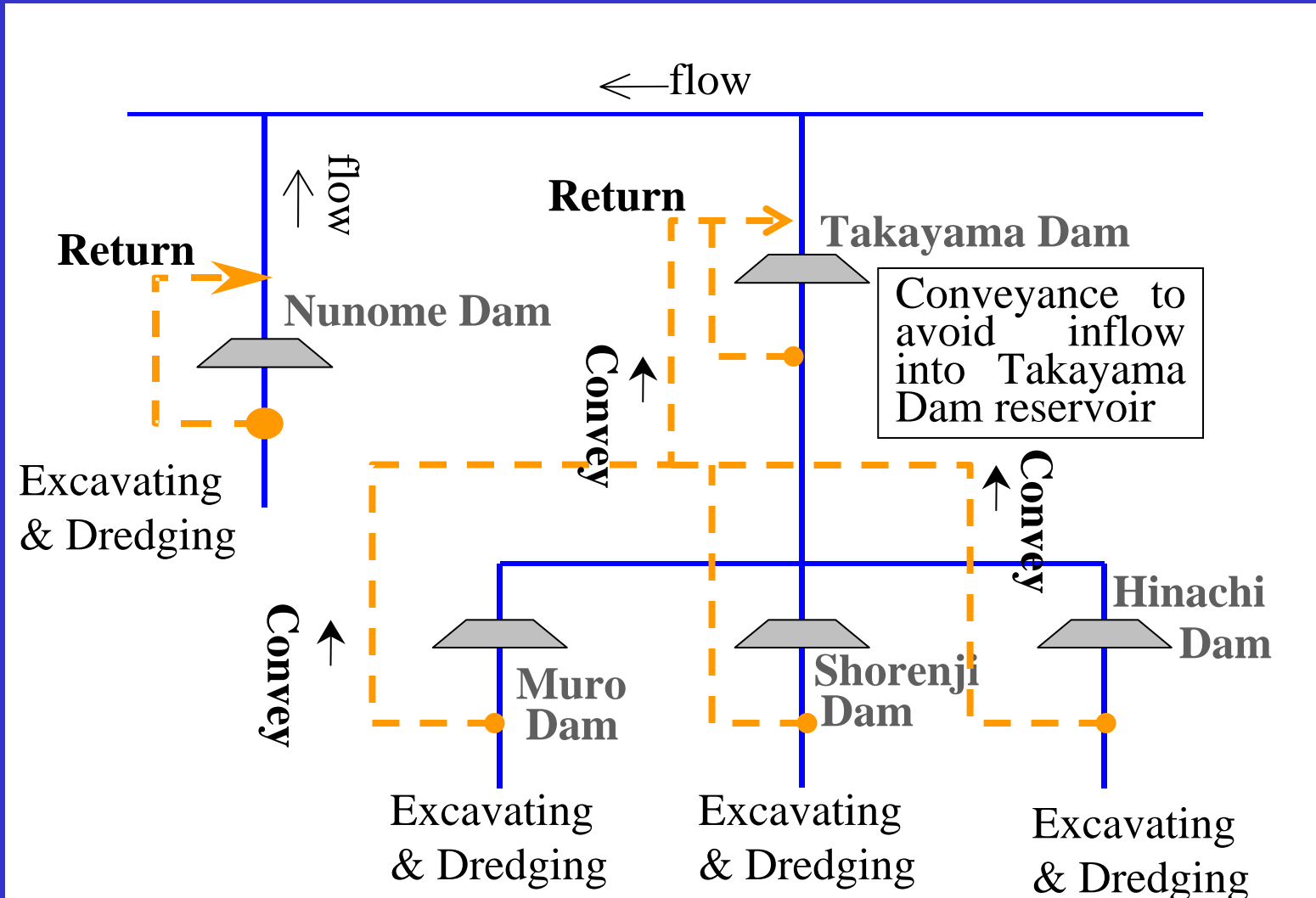
Item	Combination	Takayama Dam	Shorenji Dam	Muro Dam	Nunome Dam	Hinachi Dam
Check Dam (incl. excavation)	Reducing Water level	18,889	6,611	6,462	3,619	7,377
Excavation	Ditto	12,426	2,873	3,627	1,543	5,140
Bypass for sediment flushing	Ditto	17,682	24,161	29,957	20,234	19,173
Flushing	Dredging	10,625	10,625	10,575	10,575	10,625

Constraint conditions of reducing water level and excavation

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



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



Compensation for reducing water level → Backed up by the group of dams

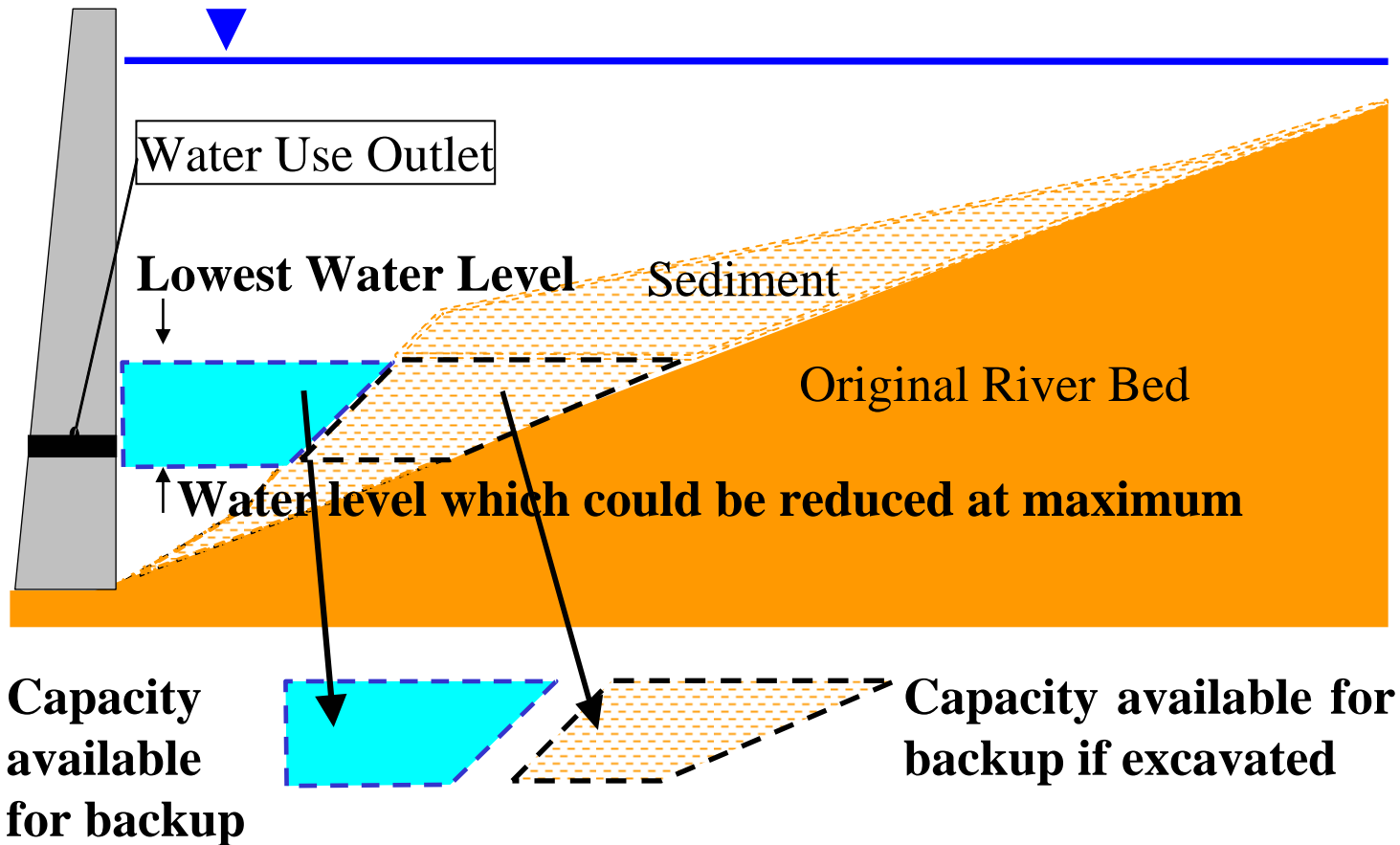
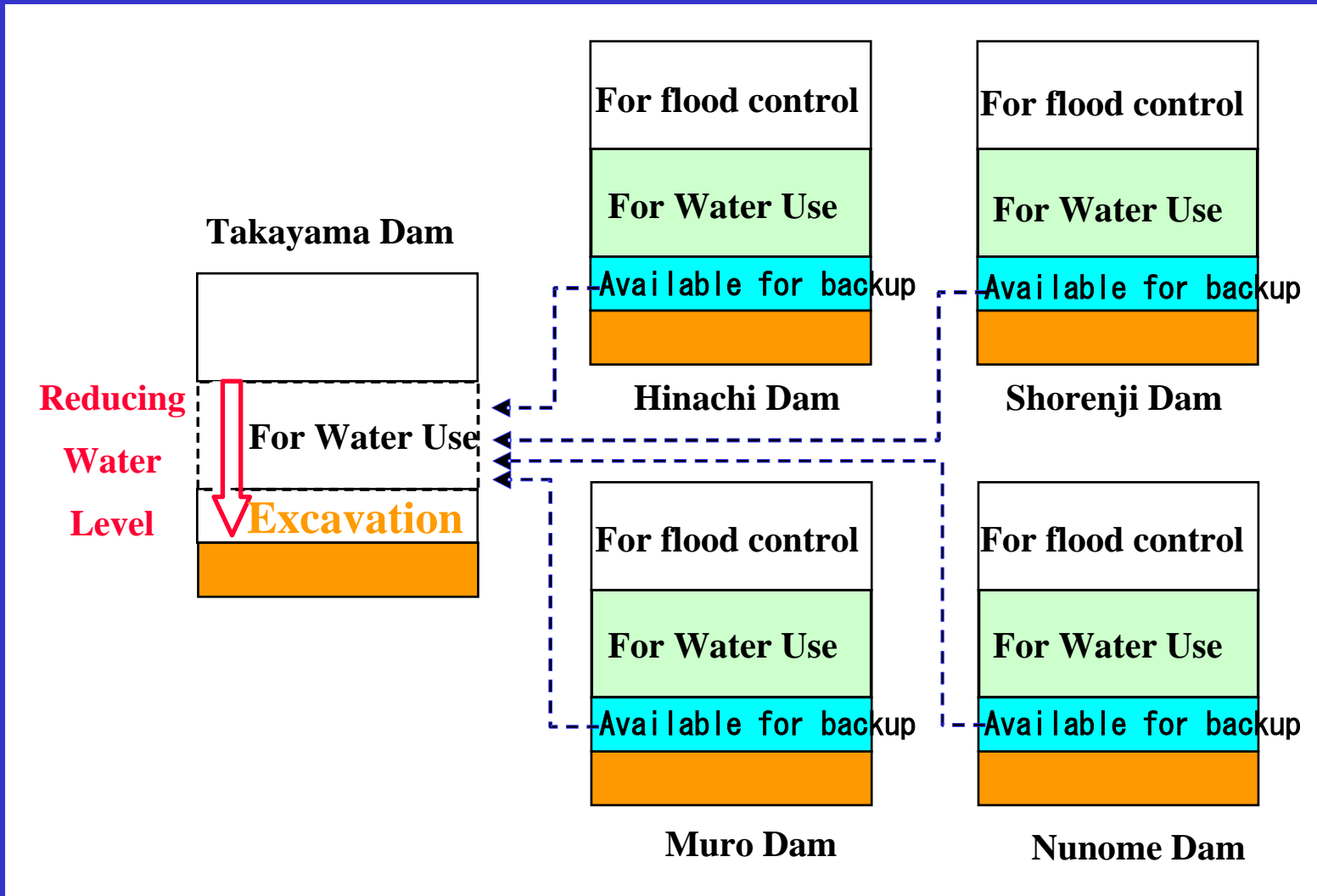


Image of collaborative operation of dams (A case of reducing water level in Takayama Dam)



Thank you very much for your attention.



5 Dams
in Kizu River System

