ANNEX 6-3

Seminar No.004

Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I

Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I

Date: 10:00 – 17:00, 25th April (Wednesday)

Venue: Hotel Novotel Manado

Chair Person: Mr. Djidon R. Watania, Head of BWS Sulawesi I

Participants: RBO Project Team at BWS Sulawesi I

Sub-dit of Hydrology Environment, Directorate of Water Resources Management

Sub-dit of O/M Dam and Lakes, Directorate of O/M, Directorate General of SDA

Time	Contents	Presenter
Opening Ceremony		
10:00 - 10:05	Singing of National Anthem Indonesia	
10:05 - 10:20	Opening Remarks	Mr. Djidon R. Watania, head of BWS Sulawesi I
10:20 - 10:25	Pray	
10:25 - 10:30	Group Photo	
Session 1: OJT1 High Water Flow Measurement		
10:30 - 10:45	Progress of Activity on High Water Flow Measurement	Mr. MIURA Hirohisa Technical Expert of JICA Project
10:45 - 12:15	Hydrology Observation in Japan -High Water Flow Measurement-	Mr. Ota Hisashi, JICA Short Term Expert (Vice-Director of Kofu River and National Highway Office, Kanto Regional Development Bureau, MLIT Japan)
Lunch		
Session 2: OJT3 Dam Operation & Maintenance Rule		
13:30 - 13:45	Sharing output of Field Seminar which was conducted on end of March	Representative of the Field Seminar Participants
13:45 - 15:15	Dam Operation & Maintenance in Japan -Organization Structure, Budget system, operation and coordination for water supply and flood control, Facility maintenance and rule/manual-	Mr. Maruyama Jun, JICA Short Term Expert (Director of River Management Office, River Environment Division, Water and Disaster Management Bureau, MLIT Japan)
15:15 - 15:45	Directions for Dam Operation & Maintenance Works and Rule/Manual in Indonesia	Mr. Adek Rizaldi, Head of Sub-dit of Dam & Lake Operation & Maintenance
Coffee Break		
Session 3: Discussion		
16:00 - 16:50	Discussion and Decision; -Procedure of high water flow measurement -Data analysis method for H-Q curve -Elements and Contents for Kuwil dam O/M rule	Mr. MIURA Hirohisa Technical Expert of JICA Project
16:50 - 17:00	Closing Remarks	Mr. Adek Rizaldi, Head of Sub-dit of Dam & Lake Operation & Maintenance

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Outline of the Project and Progress of Activity on High Water Flow Measurement at BWS Sulawesi I

25th April 2018, in Manado

MIURA Hirohisa

JICA Long Term Expert

(Water Allocation/Facility Operation and Maintenance)

Capacity Development Project for RBOs in Integrated Water Resources Management (Phase 2)

RBO: River Basin Organization

Capacity Development of RBO for **Integrated Water Resources Management (IWRM)**:

1) Decreasing **Floods** by Appropriate River Monitoring
2) Fair **Water Allocation**
3) Improving **Maintenance Work** of Water Resources Management Facilities
4) Appropriate **Stakeholder Participation**

Phase 1 (2008 – 2011)

Establishment of DUWRMT

(Dissemination Unit for Water Resources Management and Technology)

Output:

1) **Capacity Development for DUWRMT**
   - Training Module / Curriculum
   - 16 Trainings & Workshops
2) **Guidelines and Manuals for Practical Water Resources Management**
   - 55 Guidelines / Manuals in 12 Subjects
3) **Counseling Activities to RBOs**
   - Trials in 3 River Basins

Phase 2 (2015 – 2019)

Support to Capacity Development Activities for RBOs on IWRM

Aim:

1) **Strengthen Water Resource Management of RBOs in Field Practice Sites** (BBWS Ciliwung / Cisadane, BWS Sulawesi I)
2) **Capacity Development Training** for RBO
3) **Improvement of Accessibility to and Reliability of the Resources for Capacity Development**

* Modules (Phase 1), Field Training at Malang (Phase 2), Classroom Training at Manado (Phase 2),

Planned Capacity Development Training in 2016:

1) Dam Operation and Maintenance, 2) Water Allocation,
3) Flood Management, 4) Maintenance for Water Resources Infrastructure,
5) Operation and Maintenance for Irrigation, etc.

* There will be OJT Training in Japan for Indonesian Counterpart.

JICA's Previous Cooperation

- **Policy Advisor: 1962 – Present**
- **Comprehensive Development Project on Brantas River Basin: 1968 – 2011**
- **Jakarta / Jabodebek Flood Control Project: 1985 – 2013, and more.**

Capacity Development (OJT) Plan as Activity 1-6 at BWS Sulawesi 1

Activity	2017	2018
Implement flow observation of high water and update H-Q formulation		
Procedure		
1 Seminar on flow measurement		
2 Cross Section Survey for 4 locations, preparation for necessary equipment and materials		
3 Conducting flow mesurement of high water during flood or normal time		
4 Workshop on data analysis and update H-Q formulation		
5 Making a manual for flow observation, data analysis and H-Q fomulation		
Update/create maintenance manual and conduct trainings for Hydrological equipment		
Procedure		
1 Seminar on periodical maintenance work for hydrological equipment		
2 Survey and preparation for new instruments procurement		
3 Installation of new instrments		
4 Making darft check list and manual on maintenance work for hydrological equipment		
5 Conducting trainings on maintenance work for staff of BWS and operators		
6 Workshop on finalizing/updating check list and maintenance manual		
7 Continue periodical maintenance work by staff of BWS and operators		
Supoort for making draft O/M rule of Kuwil Dam		
Procedure		
1 Confirmation on detail plan/design on Kuwil Dam (including field survey)		
2 Seminar on dam operaton & maintenance rule (including field trip)		
3 Continuous discussion for making the draft Kuwil dam operation & maintenance rule		
4 Workshop on finalizing draft rule		

★ JICA Short Term Expert

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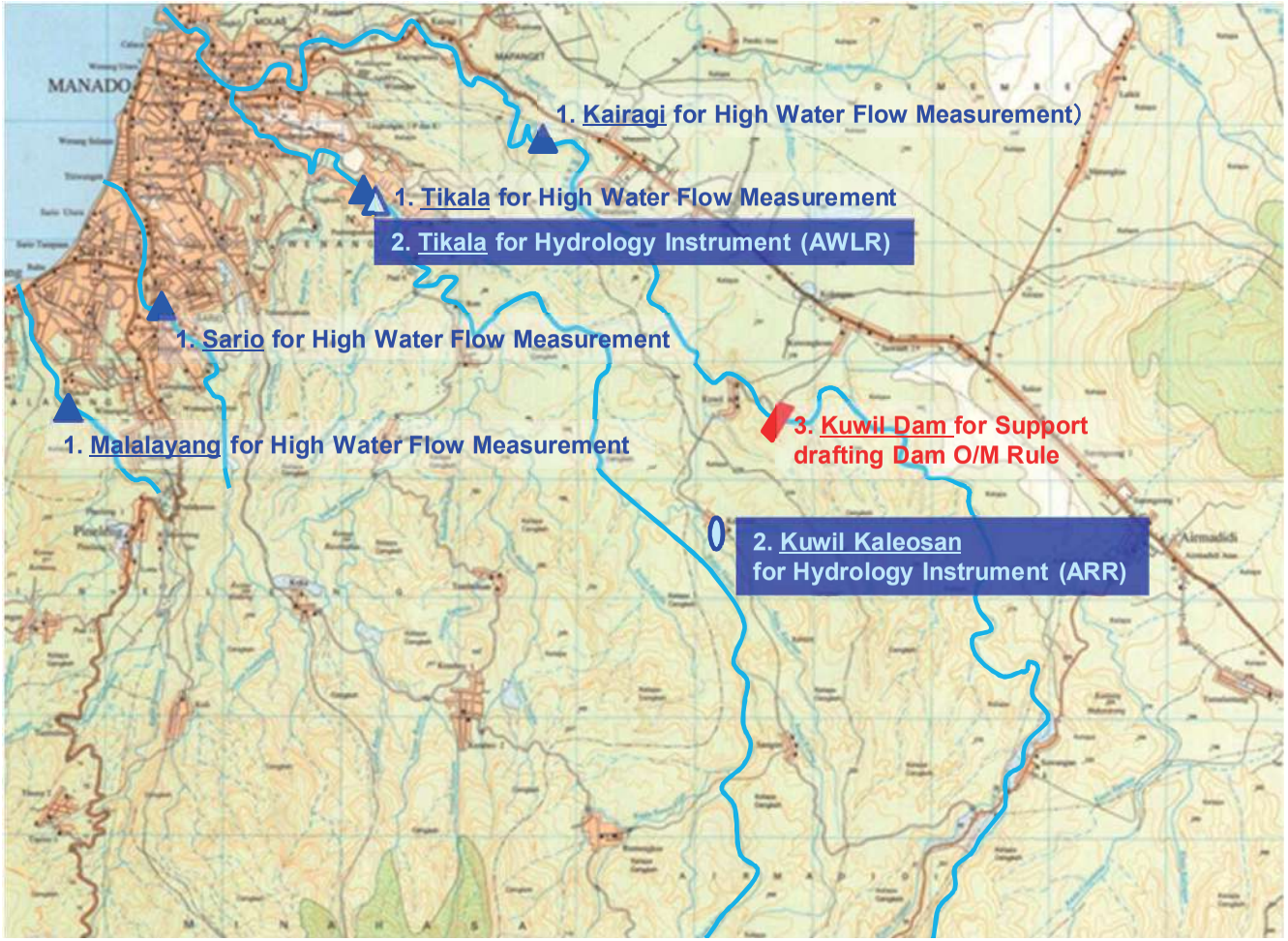
Locations for 1. High Water Flow Measurement, 2. Hydrology Instrument Maintenance, 3. Support Drafting Dam O/M Rule



1. Implement flow measurement of high water and update H-Q formulation

1) Seminar on flow measurement

14th June 2017: Kick-off Seminar on Capacity Development Activity (OJT)

25th April 2018: the Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I

2) Cross Section Survey for 4 locations and preparation of equipment

March 2018: Completed Cross Section Survey at Kairagi, Tikal and Sario

March 2018: Procured Floats (Surface: 200, 0.5m: 200, 1.0m:100)

After April 2018: Cross Section Survey at Malalayang

After April 2018: Installment of Staff Gauges at 4 locations

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1. Implement flow measurement of high water and update H-Q formulation

3) Conduct Flow Measurement

6th Mar. 2018: Practice of Float Method Flow Measurement

June or July 2018: 2nd Practice of Float Method Flow Measurement

4) Workshop on Data Analysis

8th Mar. 2018: Review on practice of Float method Flow Measurement

-Revising specification of Floats for considering on site conditions

-Reviewing river condition at float throw, 1st and 2nd observation line

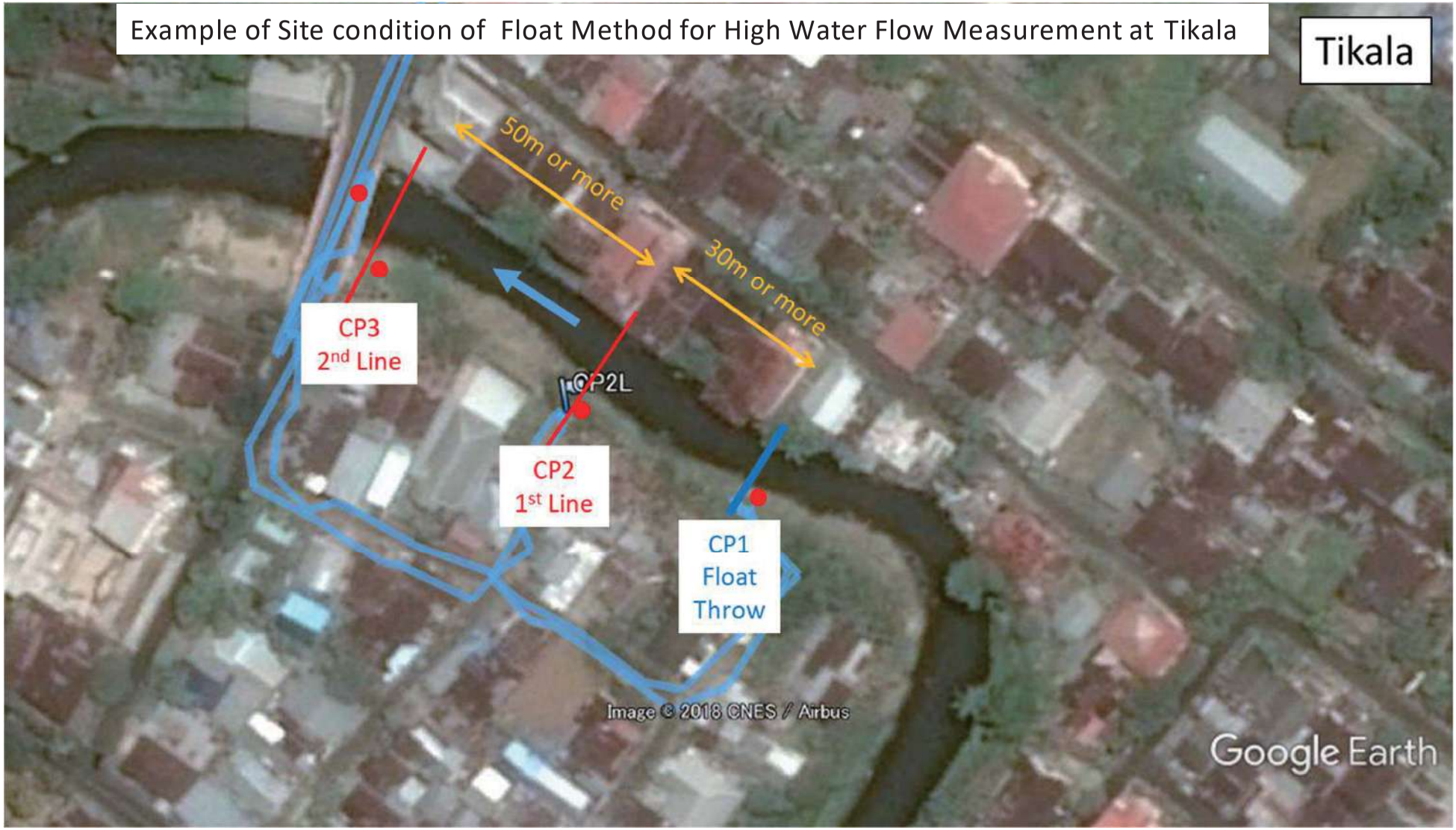
-Understanding calculation procedure/formulation of 1) cross section area, 2) Flow velocity and 3) Flow volume

25th April 2018: the Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I

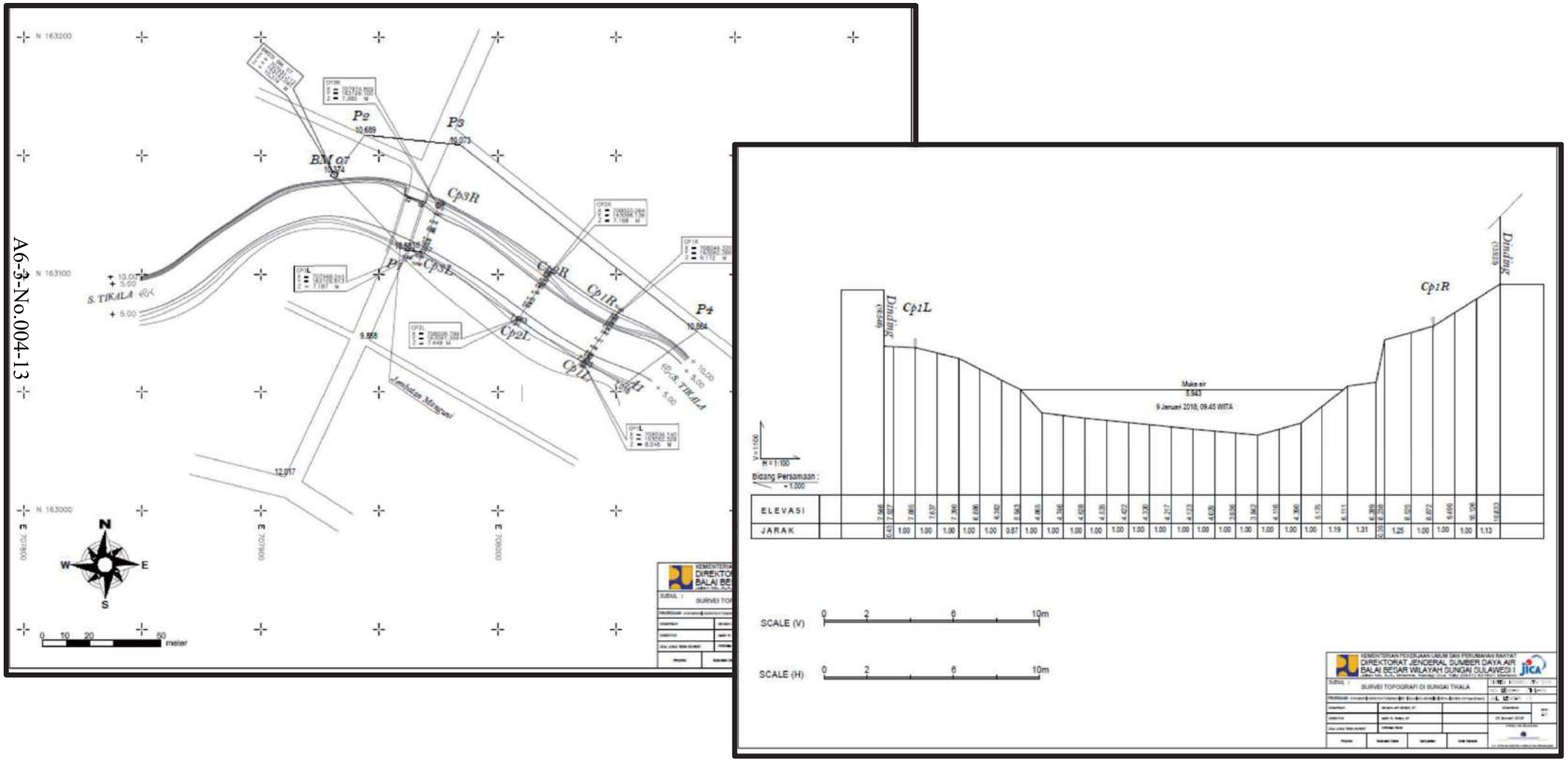
1. Implement flow measurement of high water and update H-Q formulation

5) Making Manual on Flow Measurement, Data Analysis for H-Q curve

After July 2018 (after implementation of 2nd Practice of Float Method Flow Measurement


Example of Site condition of Float Method for High Water Flow Measurement at Tikala
Tikala
50m or more
30m or more
CP3
2nd Line
CP2L
CP2
1st Line
CP1
Float
Throw
Image © 2018 CNES / Airbus
Google Earth

Outputs of Cross Section Survey at Tikala



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Photos on outputs of Cross Section Survey at Kairagi, Tikala and Sario
As a activity of 2) Cross Section Survey for 4 locations and preparation of equipment

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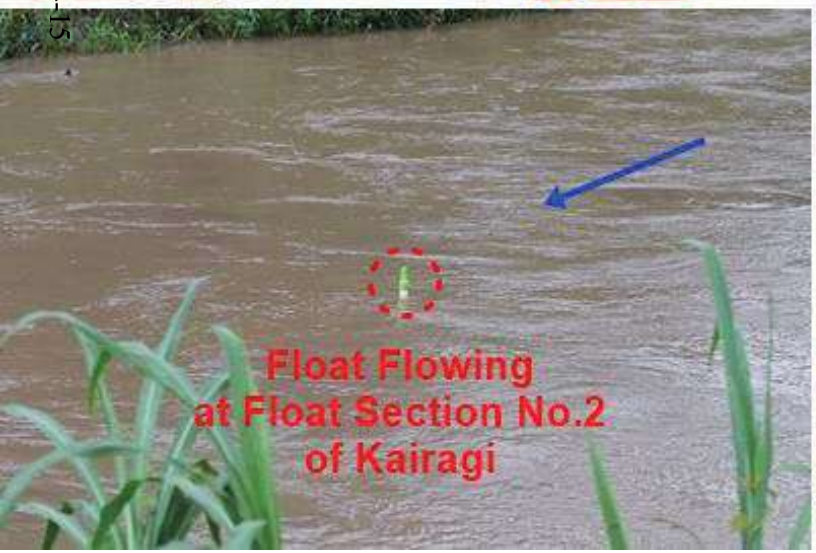
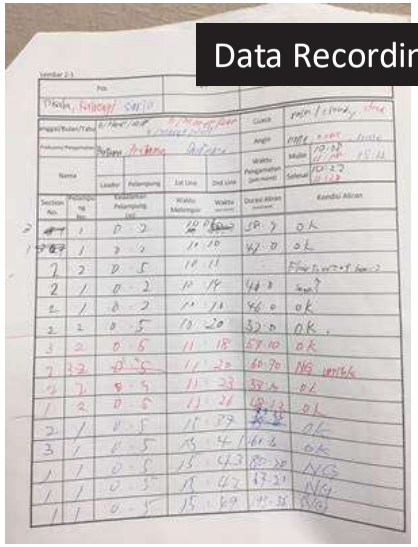
Photos on Practice of Float Method Flow Measurement As a activity of 3) Conduct Flow Measurement

Float with 1.0m
(Total length 1.2m)





Data Recording Paper

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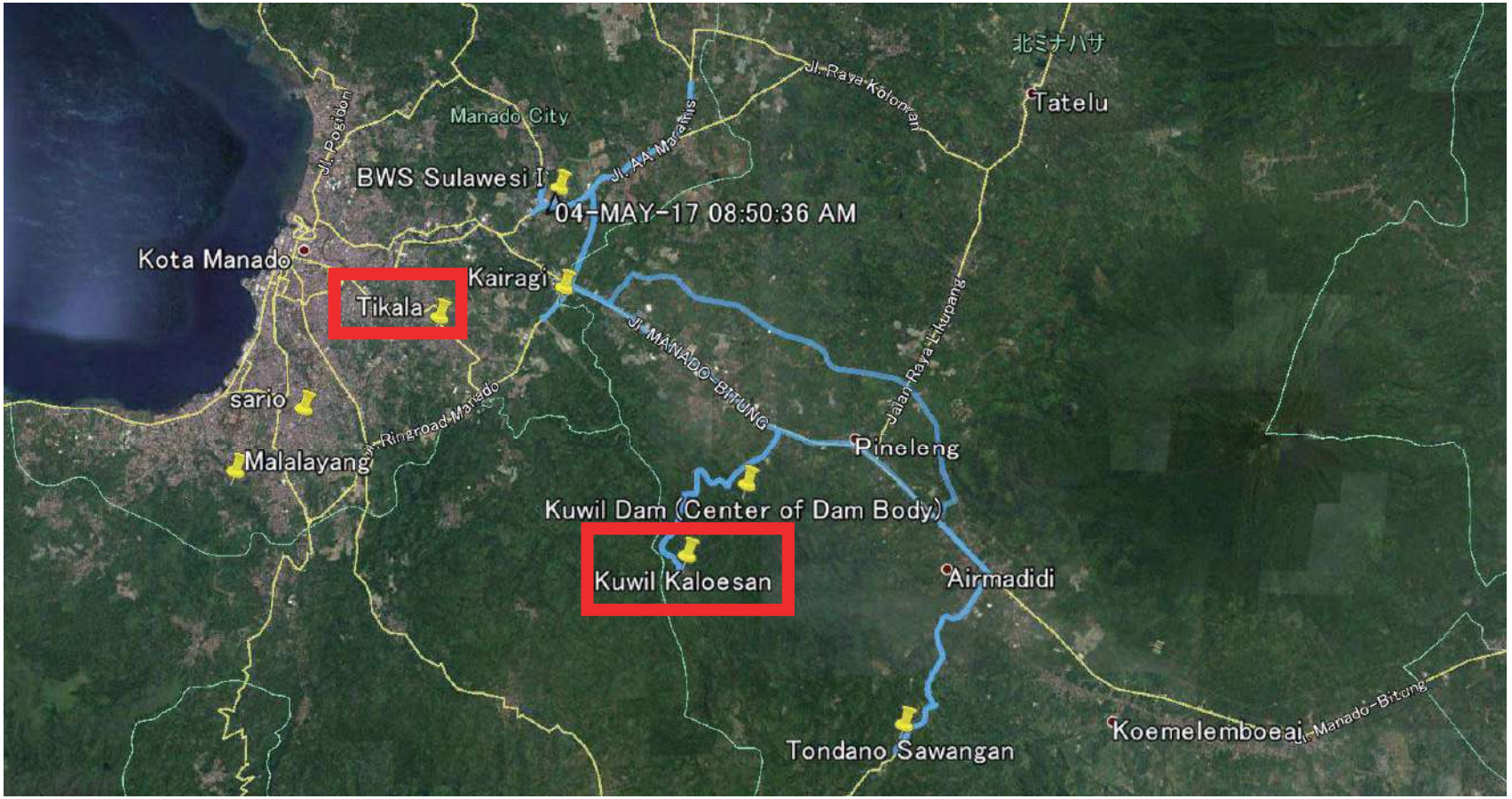
2. Update/create maintenance manual and conduct trainings for hydrological instrument



Locations of Water Level Sensor and Rainfall Gauge installation

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2. Update/create maintenance manual and conduct trainings for hydrological instrument

3) Installation of New Instrument

20th March 2018: Completion of Installation of Rain Gauge (ARR) at Kuwil Kaleosan

(Tipping Bucket Type with Data Logger and Solar Panel)

May or June 2018: Installation of Water Level (AWLR) Sensor at Tikala

(Microwave Type with Data Logger and Solar Panel)

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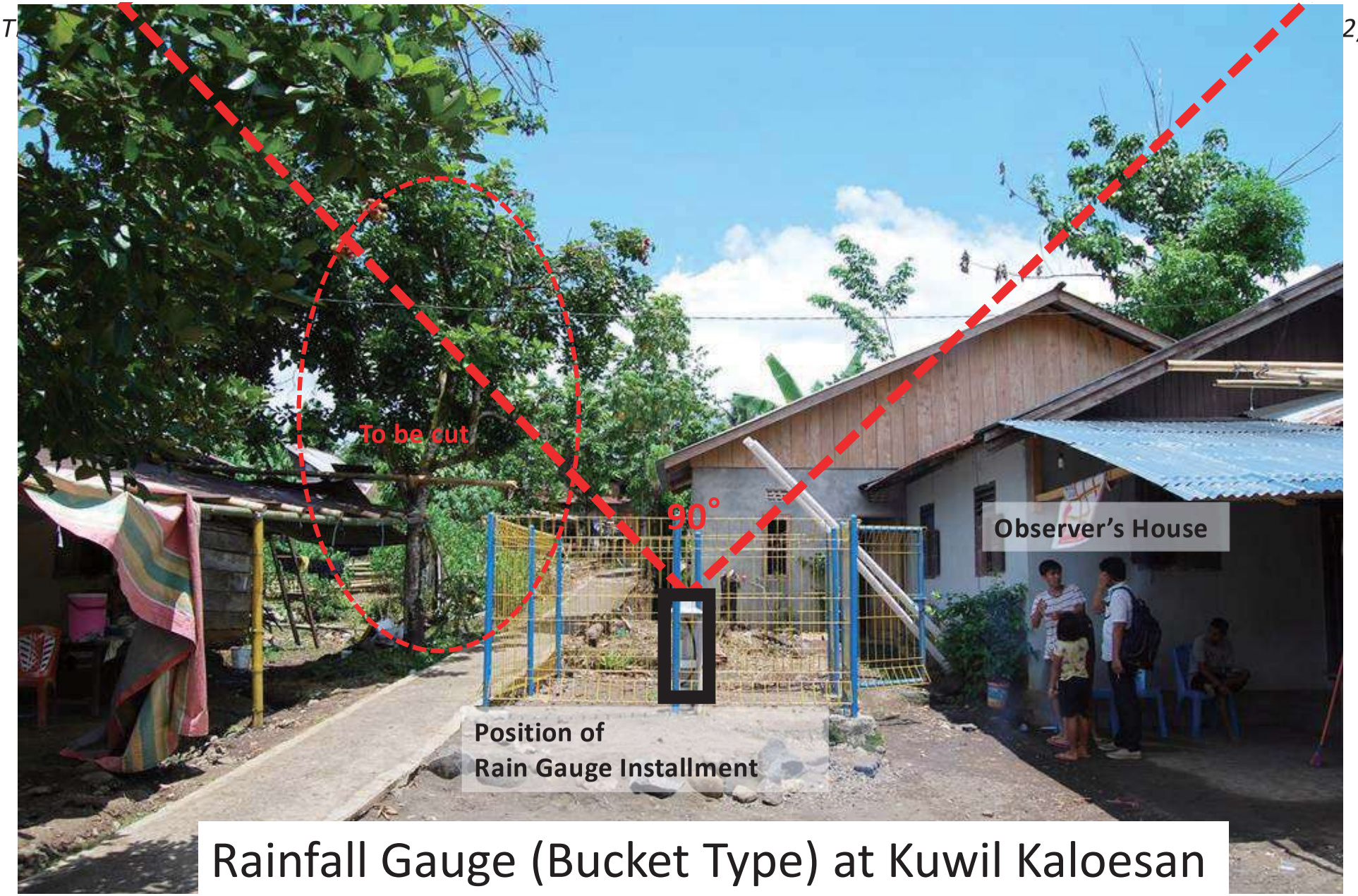
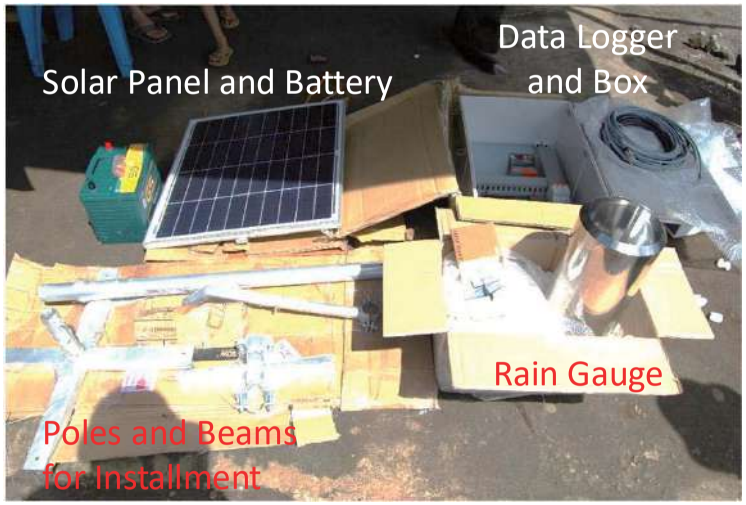


Rainfall Gauge (Bucket Type) at Kuwil Kaloesan

Transferring ARR to Mr. Djidon



Procured ARR

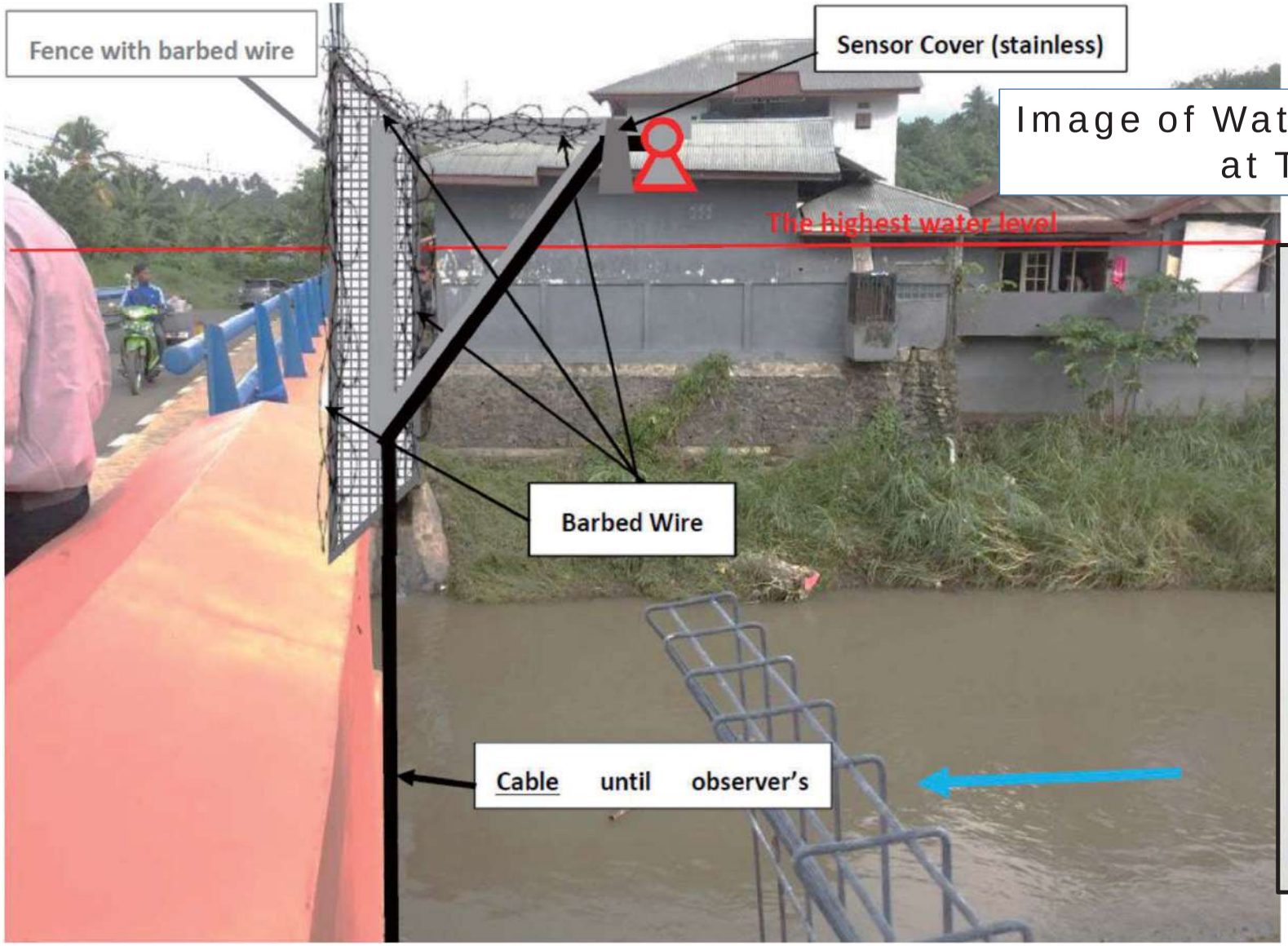
Installation Works. Removing old Rain Gauge

Sensor of Rain Gauge

Completion of ARR Installment

Practice on Operation and Maintenance ARR

Image of Water Level Sensor at Tikala



Example of Sensor

3. Support for making O/M rule of Kuwil Dam

Photos of 2nd Seminar on 21st Nov. 2017

1) Confirmation on detail plan/design of Kuwil Dam

- Technical Reports
- Design Drawings

2) Seminar on dam operation & maintenance rule

21st Nov. 2017: 2nd Seminar on Dam OP at BWSS1 Office

2nd – 6th April 2018: 3rd Seminar as a ”Field Seminar” on Dam OP

(Sub-dit Dam OP, Jatiluhur Dam, Selorejo/Sutami/Lahor/Sengguruh Dam)

25th April 2018: 4th Seminar on Dam OP “the Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I”

3) Continuous discussion for making draft Kuwil Dam OP rule

22nd Nov. 2017: Discussion with Dam Construction Project Team on OP Plan

Field Seminar on Dam Operation & Maintenance for BWS Sulawesi I

Date:

2nd April 2018 (Mon.) to 6th April 2018 (Fri.)

Schedule:

2nd April Sub-dit of OP Dam and Lakes

3rd April Jatiluhur dam, PJT II

5th April Selorejo dam, PJT I

6th April Sengguruh, Sutami and Lahor dam, PJT I

Number of Participants:

6 from BWS Sulawesi I

6 from Consultant and Contractor of Dam Projects

Purpose and Expected Result:

Participants will gain following knowledge and competence for drafting dam operation & maintenance rule of Kuwil dam

-Monitoring system of dam by Headquarters of PUPR

-Administrative frameworks for dam OP

-Procedure of operation for water utilization and flood control

-Sedimentation and watershed management

-Maintenance works for structures and facility

-Examples of dam operation & maintenance rules/manuals

Day		No.	Time	Activity	Stay
Day 0 1/April	Sun.			*Fly from Manado to Jakarta*	Jakarta
Day 1 2/April	Mon.	1	10:00 - 12:00	at PUPR General Information on this Training Seminar Discussion on Dam OP with sub-dit of Dam and Lake OP	Jatiluhur, Purwakarta
				Lunch	
			13:00 - 17:00	*Move from Jakarta to Jatiluhur Dam by bus*	
Day 2 3/April	Tue.	2	09:00 - 12:00	at PJT II Seminar on Jatiluhur dam operation & maintenance works by PJT II	Jatiluhur, Purwakarta
				Lunch	
		3	13:30 - 17:00	Field Visit to Jatiluhur dam -Dam Body -Inlet (Morning Glory) -Instruments (dam safety and hydro-meteorology) -Reservoir (Fish nets) -Hydropower Plant -Emergency Spillway	
Day 3 4/April	Wed.			*Move from Purwakarta to Bandung Airport by bus*	Selorejo
				Fly from Bandung Airport to Surabaya/Malang	
				Move from Surabaya/Malang Airport to Selorejo Dam by bus	
Day 4 5/April	Thu.	4	09:00 - 12:00	at Selorejo dam Seminar on dam operation & maintenance works by PJT I	Malang
				Lunch	
		5	13:30 - 15:00	Field Visit to Selorejo dam -Dam Body -Spillway and inlet -Countermeasures for Sedimentation	
				Move from Selorejo dam to Malang by bus	
Day 5 6/April	Fri.	6	08:00 - 15:30	Field Visit to Sutami, Lahor and Sengguruh dam -Dam Body (Sutami and Lahor dam) -Spillway and inlet (Sutami and Sengguruh dam) -Countermeasures for Sedimentation (Sengguruh dam)	Malang
		7	16:00 - 17:00	Closing Meeting with JICA Project Team	
Day 6 7/April	Sat.			*Back to Manado*	

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(Draft) Seminar on High Water Flow Measurement and Dam O/M Rule at BWS Sulawesi I

Date:

10:00 – 17:00, 25th April (Wednesday)

Venue:

Hotel Novotel Manado

Chair Person:

Mr. Djidon R. Watania, Head of BWS Sulawesi I

Participants:

RBO Project Team at BWS Sulawesi I

Sub-dit of Hydrology Environment, BPSDA

Sub-dit of O/M Dam and Lakes, OPSDA

Purpose and Expected Result:

-Deep understanding float method flow measurement and data analysis for H-Q curve

-Sharing outputs of the Field Seminar on Dam OP

-Collecting detailed information from Indonesia standards and Japanese examples for drafting Kuwil Dam OP Rule

Time	Contents	Presenter
Opening Ceremony		
10:00 - 10:05	Singing of National Anthem Indonesia	
10:05 - 10:20	Opening Remarks	Mr. Djidon R. Watania, head of BWS Sulawesi I
10:20 - 10:25	Pray	
10:25 - 10:30	Group Photo	
Session 1: OJT1 High Water Flow Measurement		
10:30 - 10:45	Progress of Activity on High Water Flow Measurement	Mr. MIURA Hirohisa Technical Expert of JICA Project
10:45 - 12:15	Float method for high water flow measurement and analysis of measurement data for H-Q curve	Mr. Ota Hisashi, JICA Short Term Expert (Vice-Director of Kofu River and National Highway Office, Kanto Regional Development Bureau, MLIT Japan)
Lunch		
Session 2: OJT3 Dam Operation & Maintenance Rule		
13:30 - 13:45	Sharing output of Field Seminar which was conducted on end of March	Representative of the Field Seminar Participants
13:45 - 15:15	Dam Operation & Maintenance in Japan -Organization Structure, Budget system, operation and coordination for water supply and flood control, Facility maintenance and rule/manual-	Mr. Maruyama Jun, JICA Short Term Expert (Director of River Management Office, River Environment Division, Water and Disaster Management Bureau, MLIT Japan)
15:15 - 15:45	Directions for Dam Operation & Maintenance Works and Rule/Manual in Indonesia	Mr. Adek Rizaldi, Head of Sub-dit of Dam & Lake Operation & Maintenance
Coffee Break		
Session 3: Discussion		
16:00 - 16:50	Discussion and Decision; -Procedure of high water flow measurement -Data analysis method for H-Q curve -Elements and Contents for Kuwil dam O/M rule	Mr. Audy, head of Section O/M, BWS Sulawesi I
16:50 - 17:00	Closing Remarks	Mr. Audy, head of Section O/M, BWS Sulawesi I

A63-No.0023

Today's Seminar is for;

1. High Water Flow Measurement

   Procedure 1: Seminar on Flow Measurement

   Procedure 4: Workshop on Data Analysis for H-Q cureve

3. Support for making O/M Rule of Kuwil Dam

   Procedure 2: Seminar on Dam Operation & Maintenance Rule

A6-3-No.004-24

Hydrology Observation in Japan

～ High Water Flow Measurement ～

Mr. Ota Hisashi

Vice-Head of BBWS Kofu,

Kanto Regional Development Bureau

Ministry of Land, Infrastructure, Transport and Tourism, JAPAN

25th April 2018

in Manado, North Sulawesi Province, Indonesia

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Contents

1. Purpose of Hydrology Observation

2. Flow Measurement

-Float Method of High Water Flow Measurement

3. Calculation of Flow rate and H-Q Curve (How to create H-Q equation)

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1. Purpose of Hydrology Observation

Definition of Hydrology Observation

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- As a wide sense, procedures to understand quantitatively each process of water and substance cycle on the earth

A6-3-No.004-28

- As a narrow sense, quantitative observation/measurement of rainfall, river water level, river flow rate, river water quality, underground water level, underground water quality and river bottom sediment

Principal of Hydrology Observation

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- We can not re-observe same situation, because same natural phenomenon will never happen

A6-3-No.004-29

- We must continue the observation

→Daily preparation is insufficient

Main Purposes of Hydrology Observation

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Rainfall, Water Level, Flow Rate

Basic data for statistical analysis, run-off calculation and planning

River O/M

Flood Control

Flood-Fight and others

Drought Management

Restriction of water intake

Flood Control Plan

Design Flood before Control

Design High Water Discharge

River Channel Plan

Water Utilization Plan

Water Resources Development Plan(Dam Construction)

Normal Discharge

A6-3-No.004-30

Some Hydrology Stations that MLIT manages have observed since 100 years ago and more

- On 10th June 1873, staff gauge for water level observation was installed at river mouth of SUMIDA River in TOKYO, we has started water level observation. 0.0m at the staff gauge had been legislated as an Original BM (Benchmark) for elevation in Japan “0.0m”. The “0.0m” was setup by average data from survey result from 1873 to1879. The “0.0m” is named “Arakawa Peli” as A.P.
- Systematic hydrology observation by MLIT has been started from 1938, when 1st version of rainfall and river flow rate annual reports
- In 1938, electricity was not supplied to country side in Japan
- MLIT has hydrology observation data of 1945, it was at end of World War II, even in difficult situation, such as national land was devastated, many of social infrastructures were destroyed and starvation happened

REIGANJIMA Water Level Station

Source: website of TOKYO Metropolitan Government

Hydrology Observation by MLIT

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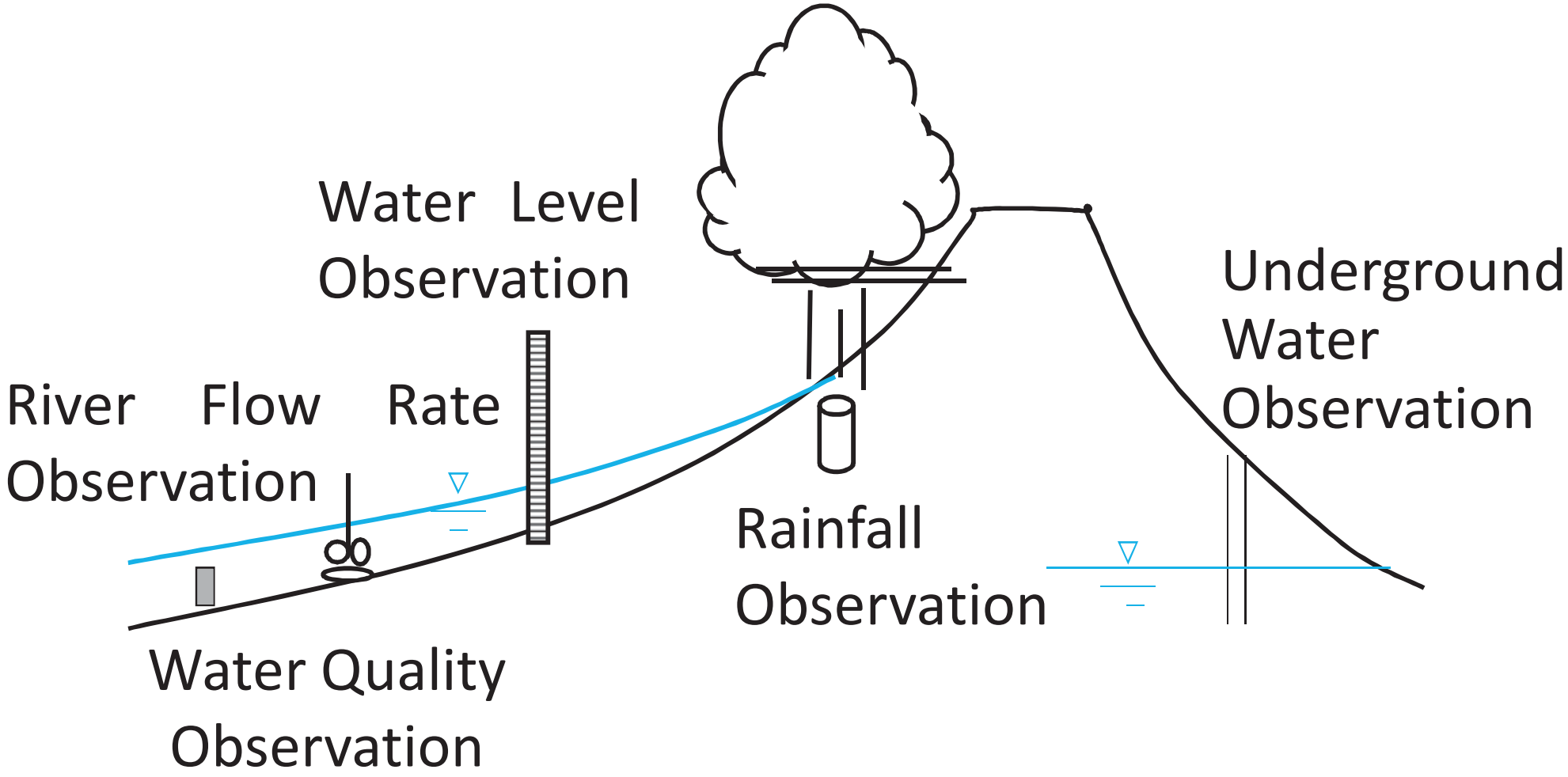

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Definitions of Hydrology Observation

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Rainfall:

Water depth if rain, snow, sleet and hail is storage on the plat place

River Water Level:

height of water surface from standard level

River Flow Rate:

Volume of water that flows for one (1) second at cross section of river

Underground Water Level:

Height of ground water level from standard level

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Technical Manuals

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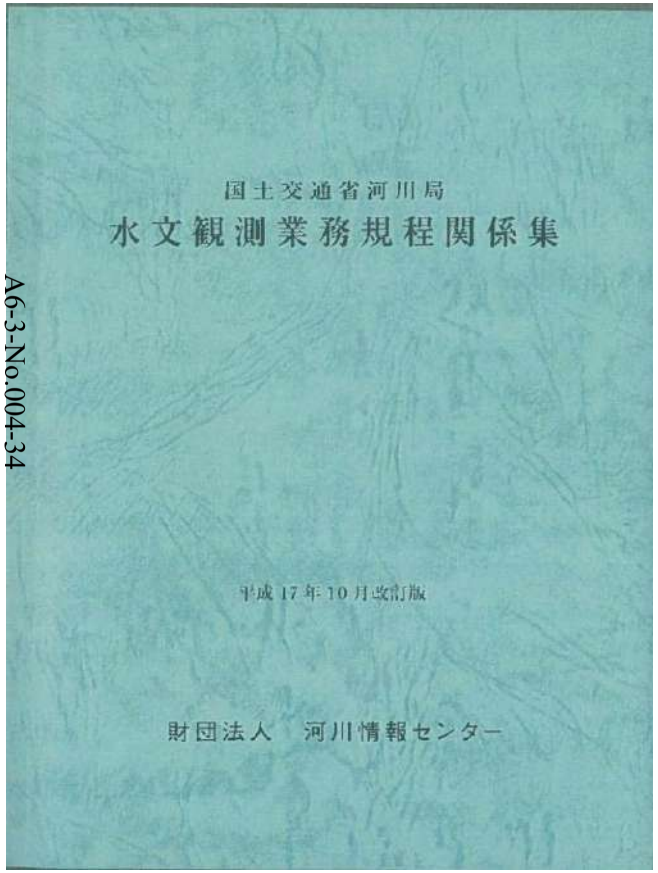
Technical Rules for Hydrology Observation
MLIT



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Technical Manual for Hydrology Observation
Japan Construction Technical Association

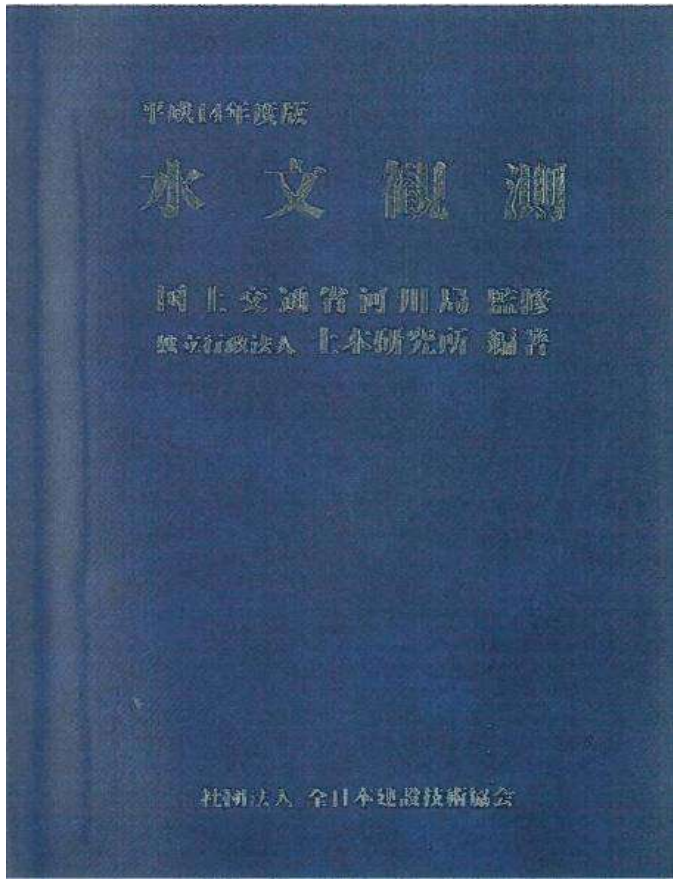

Illustration of Hydrology Observation
Chubu Construction Association

2. Flow Measurement

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Flow Rate

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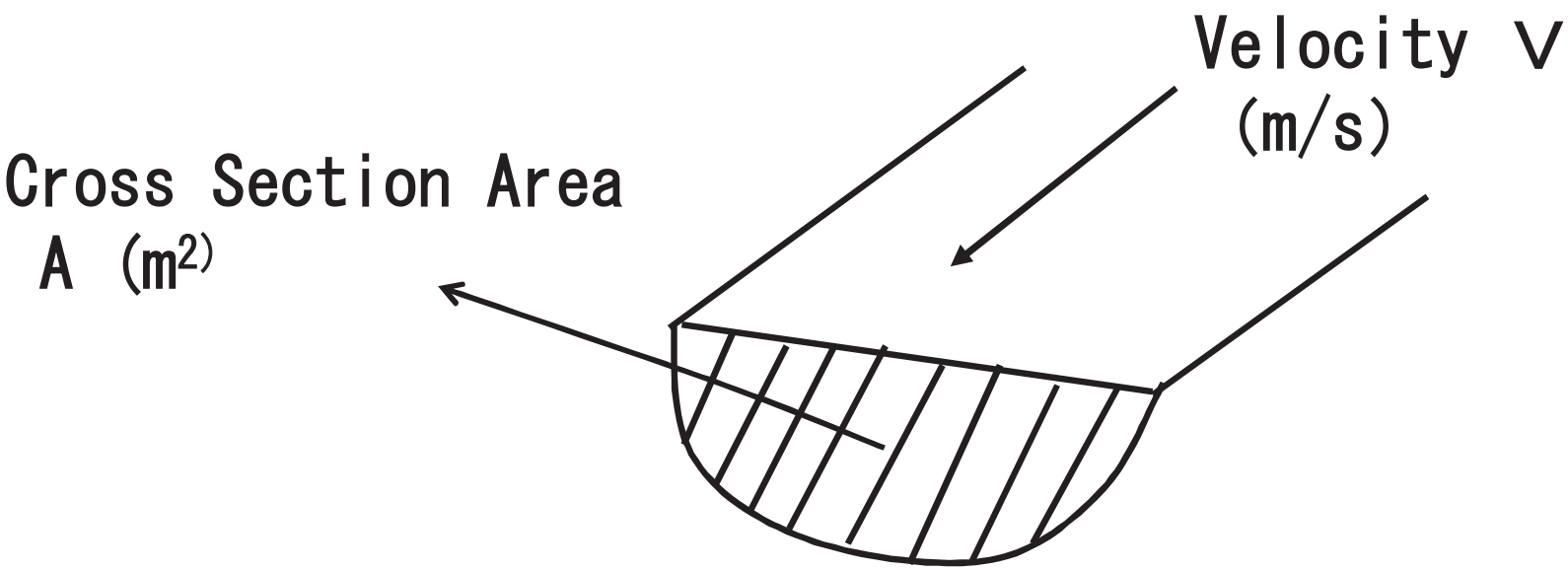
Flow Rate: Water volume that flows at a Cross Section for one (1) second



Flow Rate Q = Cross Section Area A × Velocity V

(m^3/s) (m^2) (m/s)

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Procedure of Flow Measurement

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Procedure of Flow Measurement is classified by condition of site, scale of flow rate, frequency and accuracy of the measurement

1. Current Meter Method: mainly for Low Water Flow Measurement

2. Floats Method: Mainly for High Water Flow Measurement

In Japan, two (2) methods mentioned above are most popular method

3. Others: 1) Current Profiler, 2) Radio Wave Type Current Meter, 3) Image Processing method

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Procedure of Flow Measurement

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Float Method for Flow Measurement

In Japan

1. It is difficult to install instrument in/on the water. Because many drift-wood and garbage flow during the flood (It makes instrument breaking)
2. Float method is adequate, because special instrument and high level technique are not necessary
3. Float method has been applied for long time since high water flow measurement was regulated in 1954 (1.300 locations by central government, 800 locations by province)
4. Float method is safe, simple. It can measure with acceptable accuracy

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Merits and demerit of float method

1. Merits

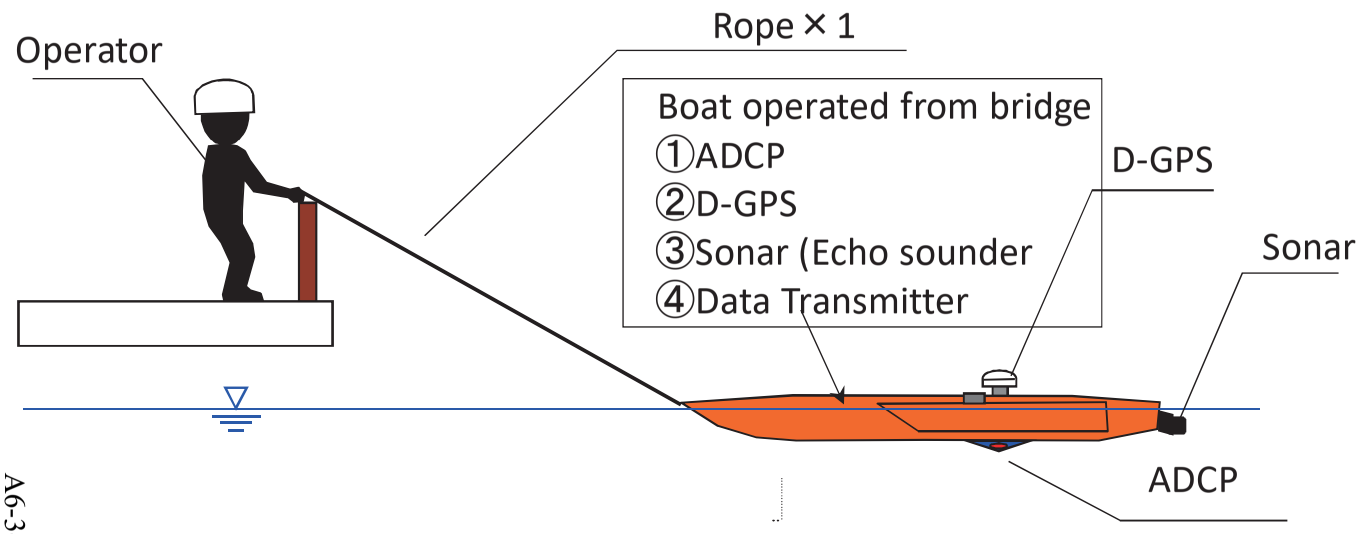
- It can measure flow velocity directory
- It is applicable for various conditions of water depth and flow velocity
- It can measure flow velocity of right angel against cross section
- It is low cost for material and equipment

A6-5-No.004-39

2. Demerits

- Several observers are required
- It is sometimes difficult that floats can flow straightly
- Coefficient that depends on Float's depth in the water depth of float must be apply for velocity calculation
- Measured data is fluctuated a bit by flow direction

Current Profiler (ADCP)



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Ultrasonic wave reflects suspended sediment, plankton and garbage. If scatterer moves, frequency (Hz) of reflected wave was changed by the Doppler effect. We can calculate flow velocity at right angle of cross section by capacity of variations.

It sends ultrasonic wave to four (4) directions so that it can observe flow directions with three (3) – dimensions

Current Profiler (ADCP)

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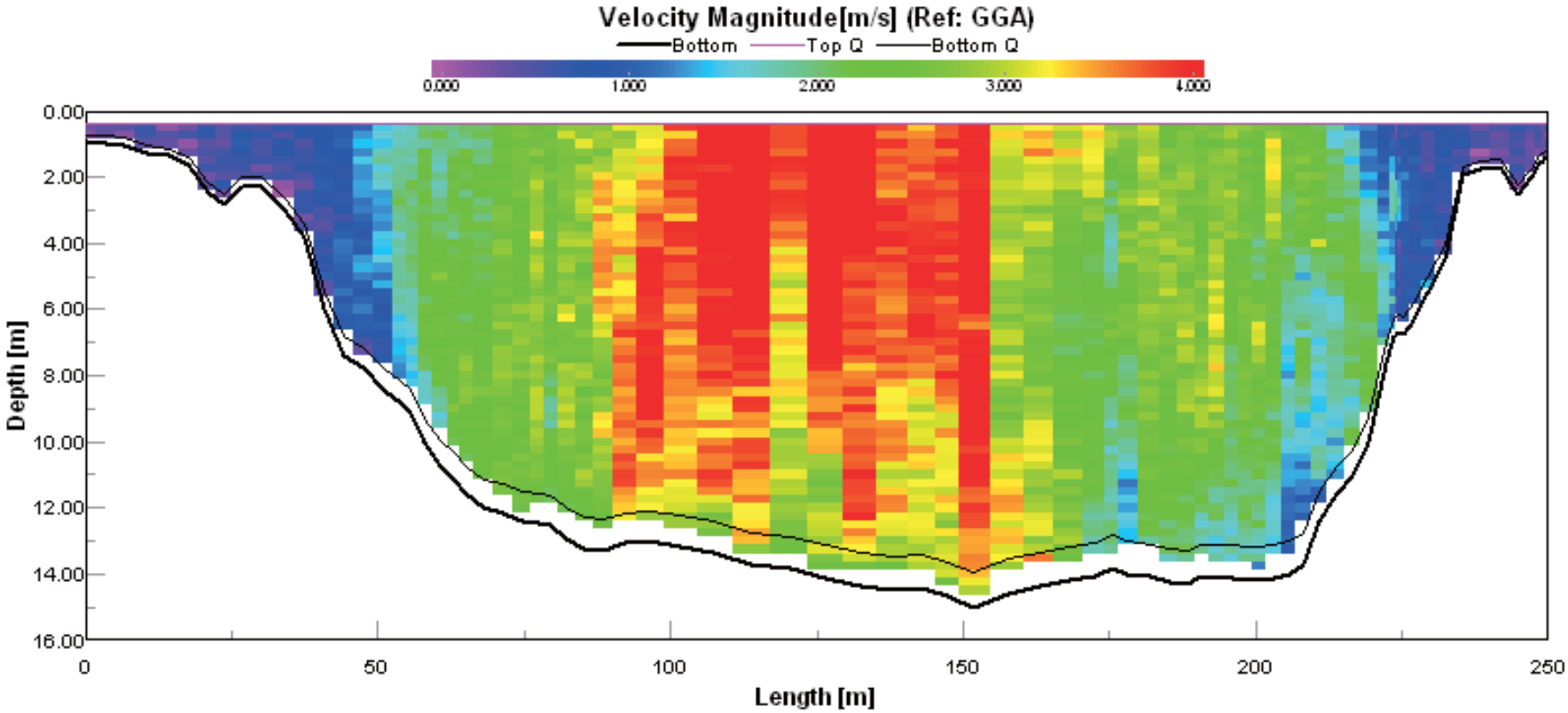

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Merits and Demerits of ADCP

1. Merits

- Resolution of data is high, we can get mesh and real time riverbed elevations
- It is expected new technique development that can be get more various data

A6-3-No.004-42

2. Demerits

- Skilled operator for boat is required. We have to operate carefully when the boat moves from riverbank side to river center where flow velocity is fast
- It takes a time for preparation. High skill of observer and operator are required
- There are many materials and equipment for ADCP

Radio Wave Type Current Meter

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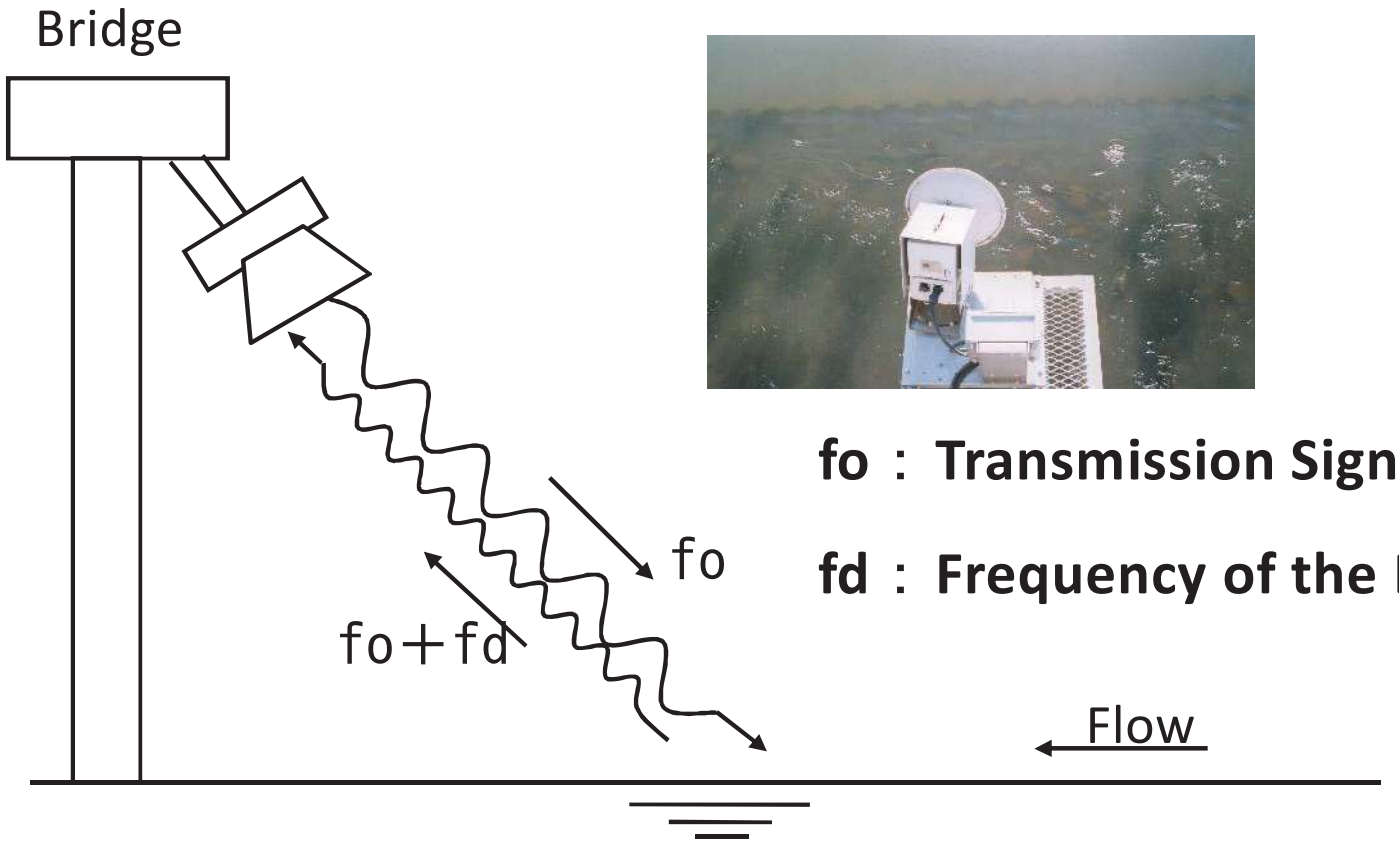

fo : Transmission Signal Frequency

fd : Frequency of the Doppler

Radio Wave Type Current Meter transmits radio wave from antenna to water surface. It can measure current velocity of water surface by the Doppler Shift (changing frequency). It can measure continuously without any operators at the site

A6-3-No.004-43

Merits and Demerits of Radio Wave Type

1. Merits

- Operation is simple, everyone can operate
- Duration of measurement is short
- Fluctuations by different operation is small
- Materials and equipment is not so many

A6-3-No.004-44

2. Demerits

- Unstable water surface condition (waves at surface) is required for measurement
- Instrument must be installed parallelly against river water flow direction
- It cannot measure if distance between antenna and water surface is far
- It cannot get changing of cross section

Image Processing Method

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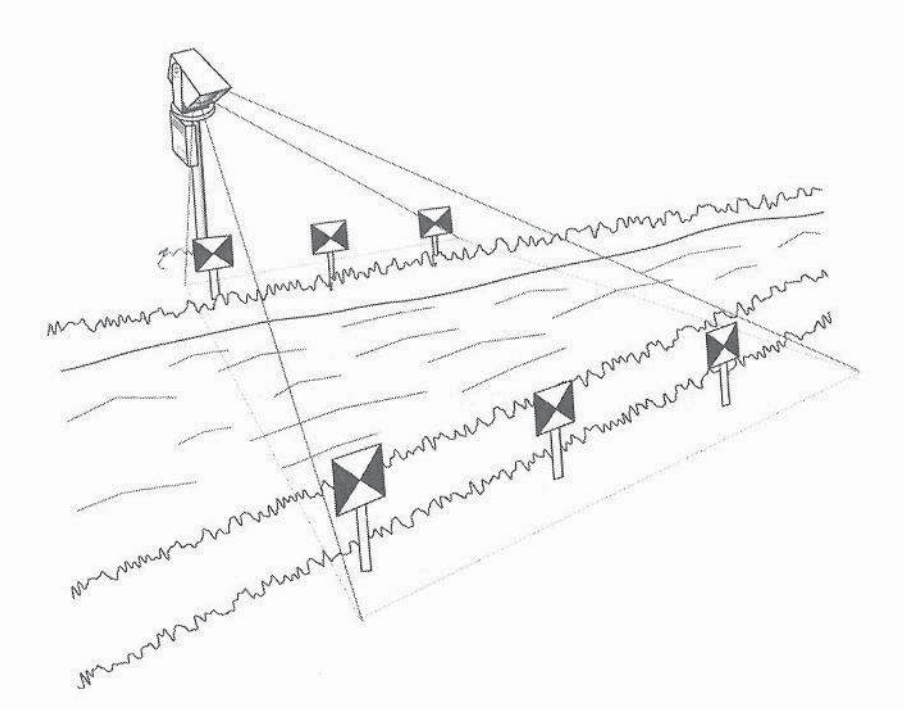
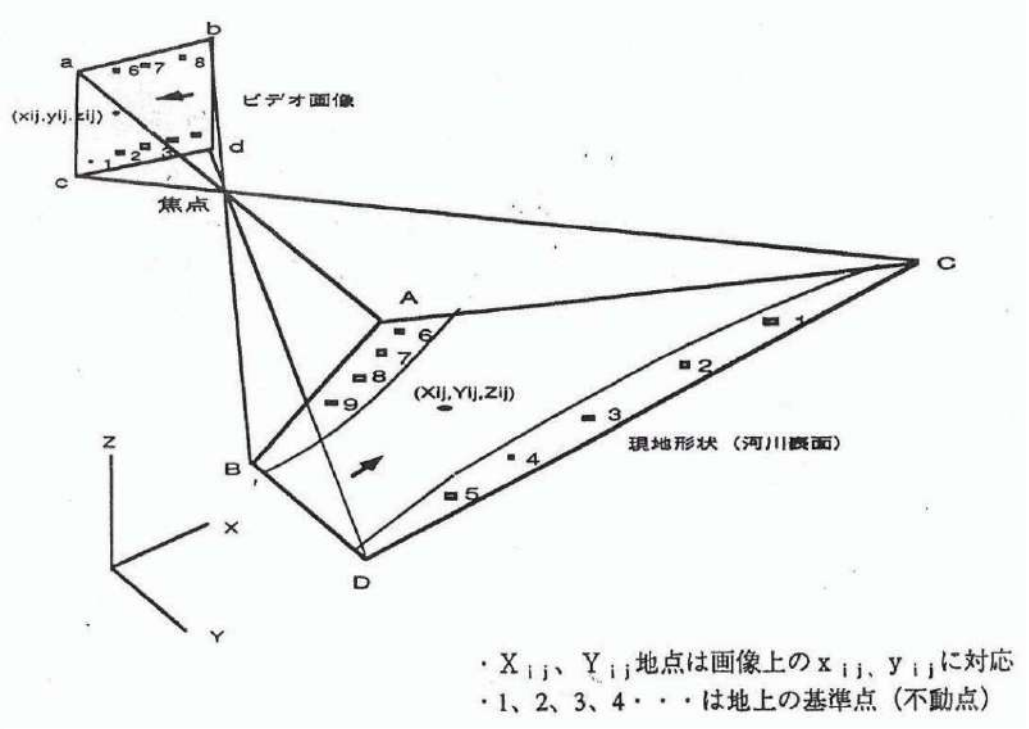
Image Processing Method captures conditions of river water surface by video camera that is installed at riverbank or bridge. Surface current velocity can be measured by moving velocity of garbage and the image gradation. It can measure with two (2) dimensions

A6-3-No.004-45





Video Measurement: measuring garbage and bubbles, 2-D measurement is possible

Merits and Demerits of Image Processing Method

1. Merits

- It is applicable everywhere
- It can get distribution of current velocity in 2-D in one time measurement

A6-3-No.004-46

2. Demerits

- There is limitation of angel for capturing images (difficult at big river)
- In case of infrared camera, it is a bit difficult to recognizing contrast
- It can not measure cross section changing

Ultrasonic Type Current Meter

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Same as Radio Wave Type, antenna should be installed with vertical against river cross section, and sends signal (ultrasonic signal) to upstream side to measure surface velocity by the Doppler Effect. It can measure continuously without observer/operator at the site

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Fixed type at Bridge

Mobile type

Selection of flow measurement location

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To select flow measurement locations, we have to consider conditions as below;

1. Water flow is stable

   → There should not be river line bend at up and downstream

2. Water flow should not be too fast and too slow

   → Current meter sometimes can not measure the velocity

3. Changing river channel and riverbed is a little

   → Accuracy of measurement will be much low

4. Measurement can be done even in drought situation

   → Adequate accuracy is required in drought situation

5. Low security risk for measurement

   → Flow measurement is relatively dangerous than other observation

6. Easy access to the site

   → The sites must be convenient location for bringing materials and equipment. Because flow measurement is immediate works

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Calculation method of flow rate

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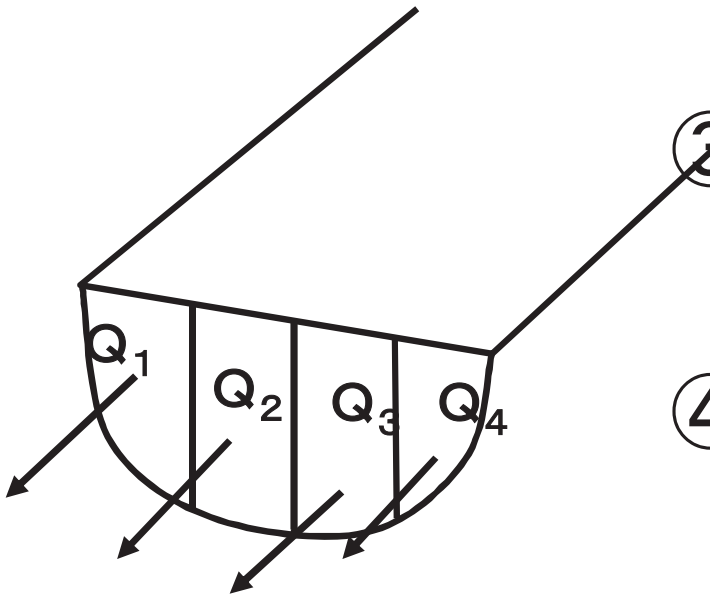

① Dividing cross section into several sections

⇩

② Measuring representative velocity at each sections

⇩

③ Calculation of flow rate at each section
（velocity）×（area of section）

⇩

④ Accumulating flow rate of sections to get total flow rate

Flow Rate: $Q = Q_1 + Q_2 + Q_3 + Q_4$

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A6-3-No.004-50

2. Flow Measurement

-Float Method of High Water Flow Measurement-

Float Method of High Water

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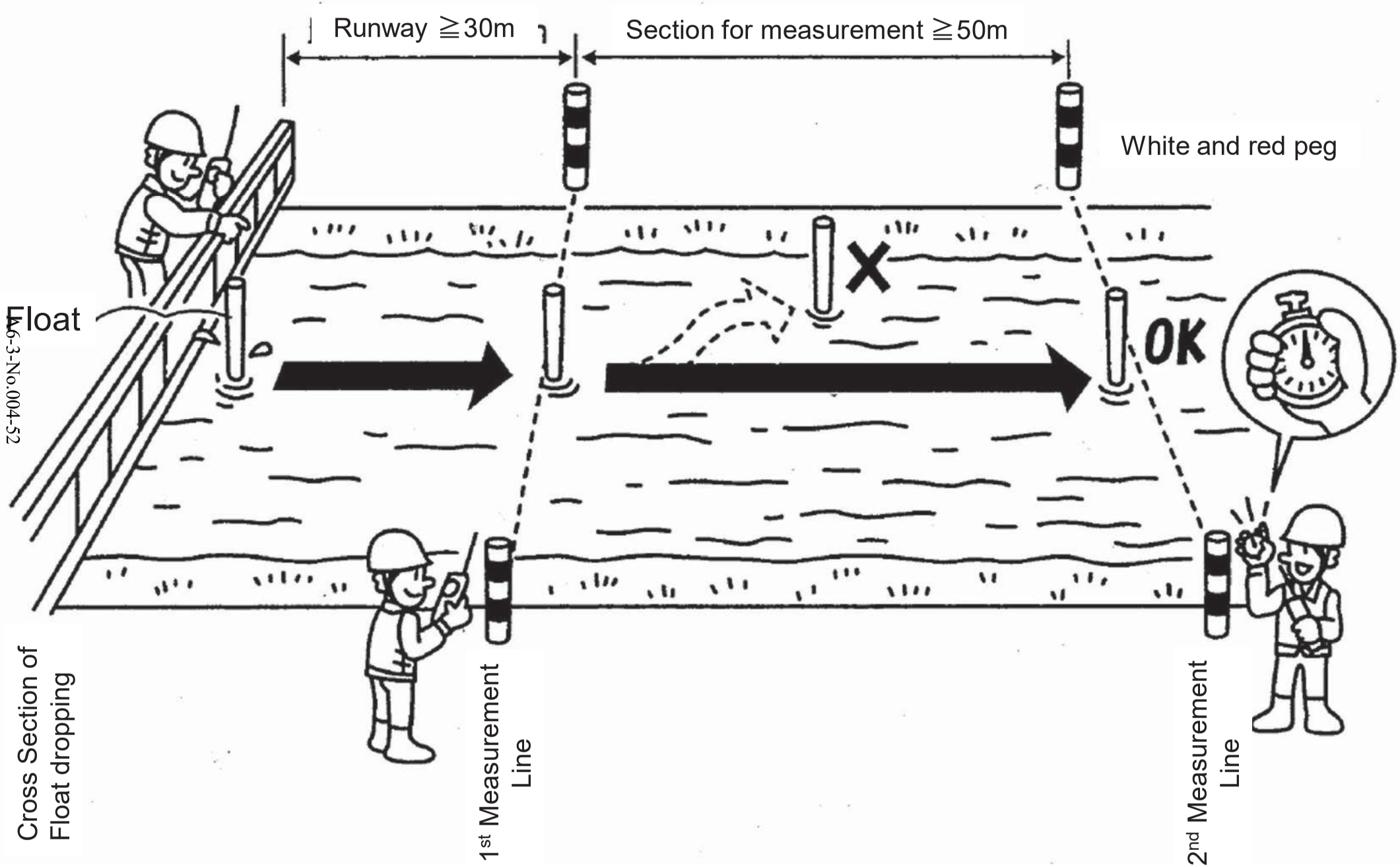
- dropping floats from bridge or other position, measuring duration of float flowing in one section

A6-3-No.004-51

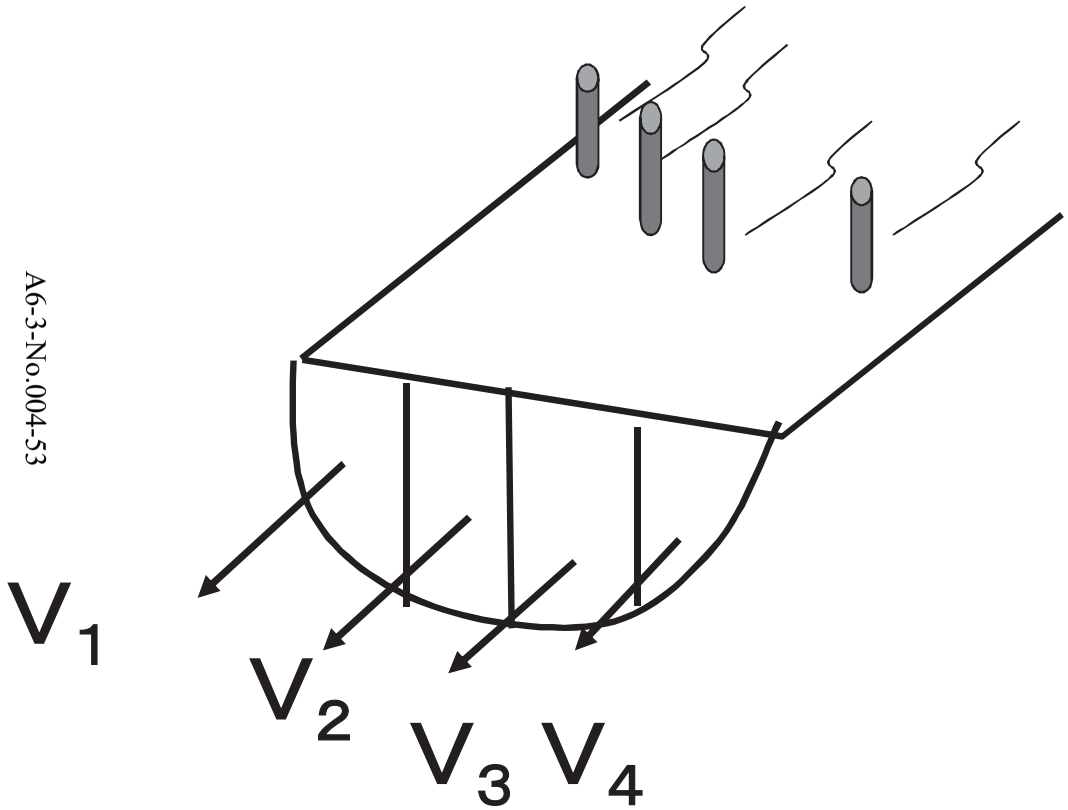
- Calculation of float flowing velocity, distance of the section is divided by duration of float flowing

Image of Float Method



Ⅵ6-3-No.004-52

Number of float sections



A6-3-No.004-53

Velocity distribution at cross section direction is not same

↓

Velocity should be measured at each float sections

↓

Number of float section depends on river water width

Standard on number of float section

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（a）Relations between river water width and number of float section

River Water Width	Less than 20m	20～100m	100～200m	200m以上
Number of Float Sections	5	10	15	20

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Number of float section is regulated by river water width as table above

（b）Relations between river water width and number of float section in emergency case

River Water Width	Less than 50m	50～100m	100～200m	200～400m	400～800m	Over 800m
Number of Float Section	3	4	5	6	7	8

Float Type

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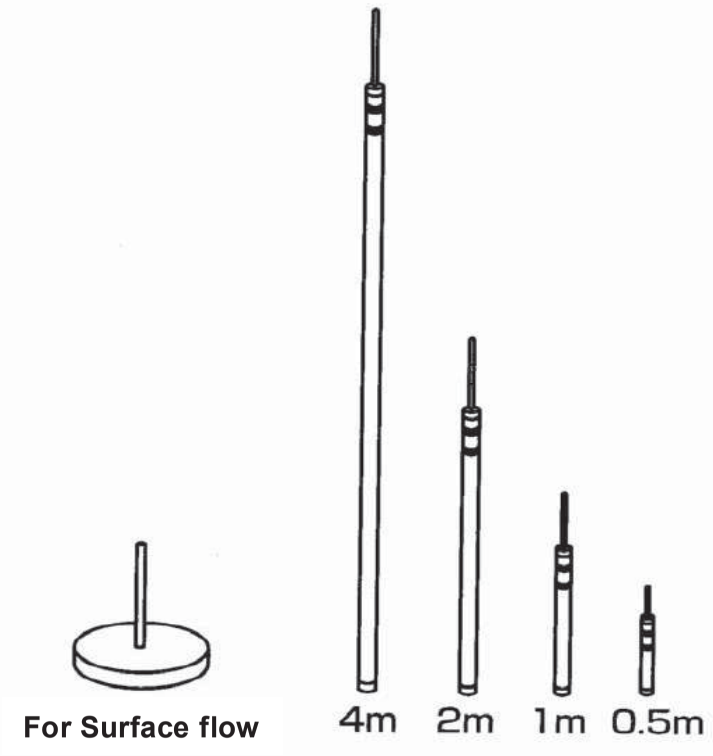
Float flows with keeping stable Float's depth in the water. Inside of float pipe is adequate rate of sand. Length of the float is regulated by water depth.

A6-3-No.004-55



Coefficient of float

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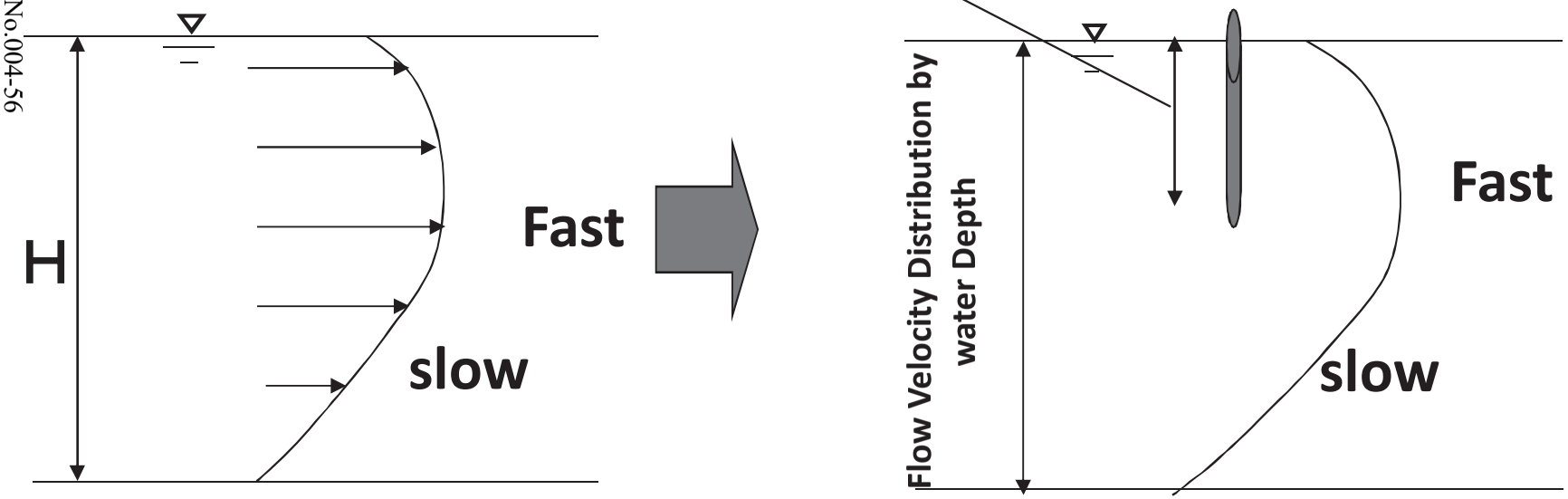
Float can measure only this part, therefore velocity of float flowing is faster than average velocity

Therefore, coefficient of float that calibrates to average velocity is indispensable

A6-3-No.004-56



Velocity is distributed by water depth

Direction of velocity is distributed by water depth

Coefficient of float

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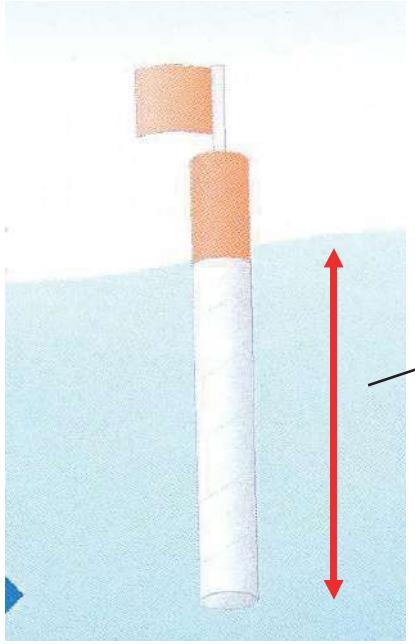
Coefficient was regulated by length of Float. There is not standard specification on diameter of the float



“Float's depth in the water” is length of float under the water

A6-3-No.004-57

Float No.	1	2	3	4	5
Water Depth（m）	Less than 0.7	0.7～1.3	1.3～2.6	2.6～5.2	5.2以上
Float's depth in the water（m）	Float for Surface water	0.5	1.0	2.0	4.0
Coefficient of the float	0.85	0.88	0.91	0.94	0.96

Float Table

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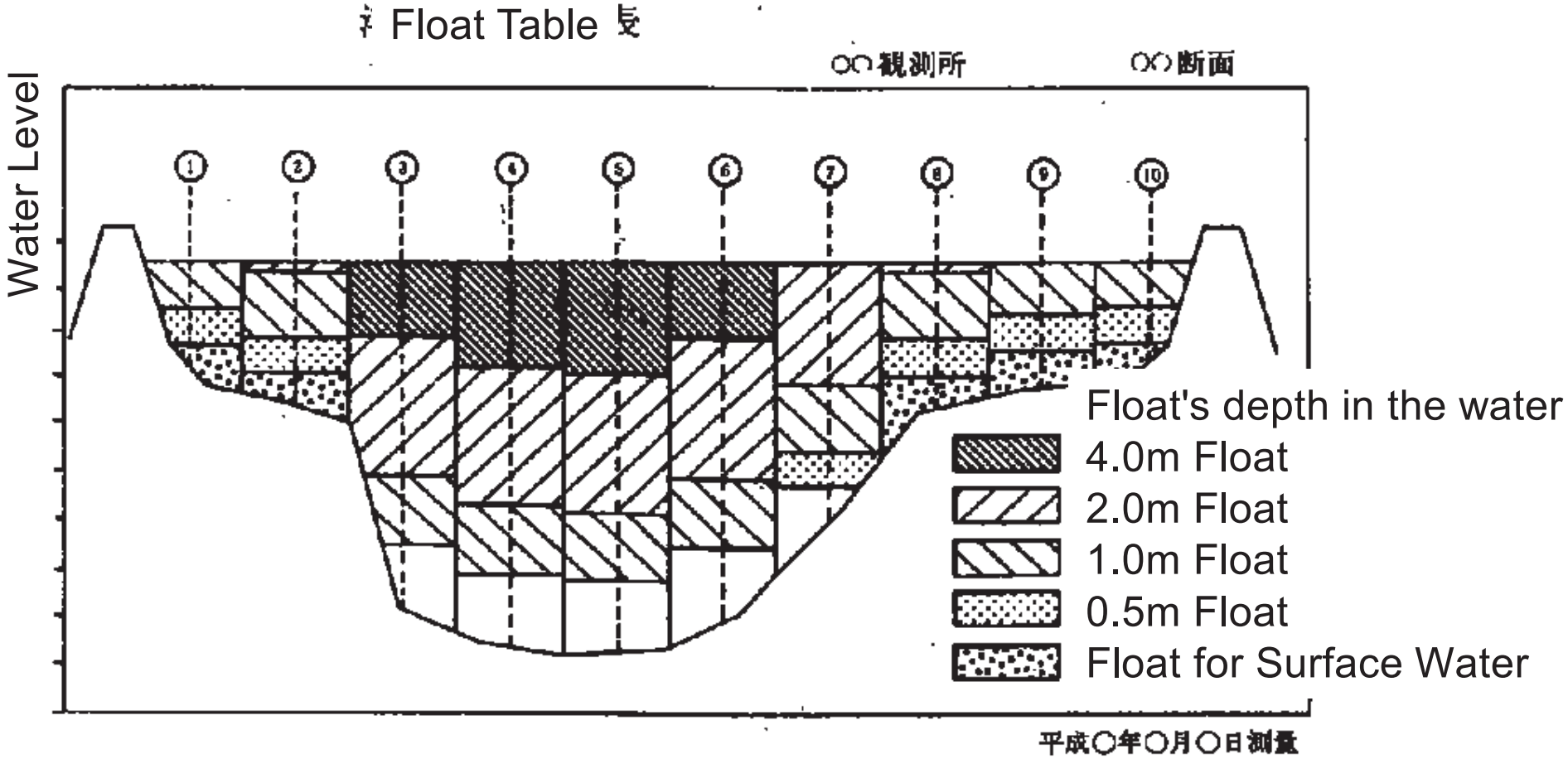
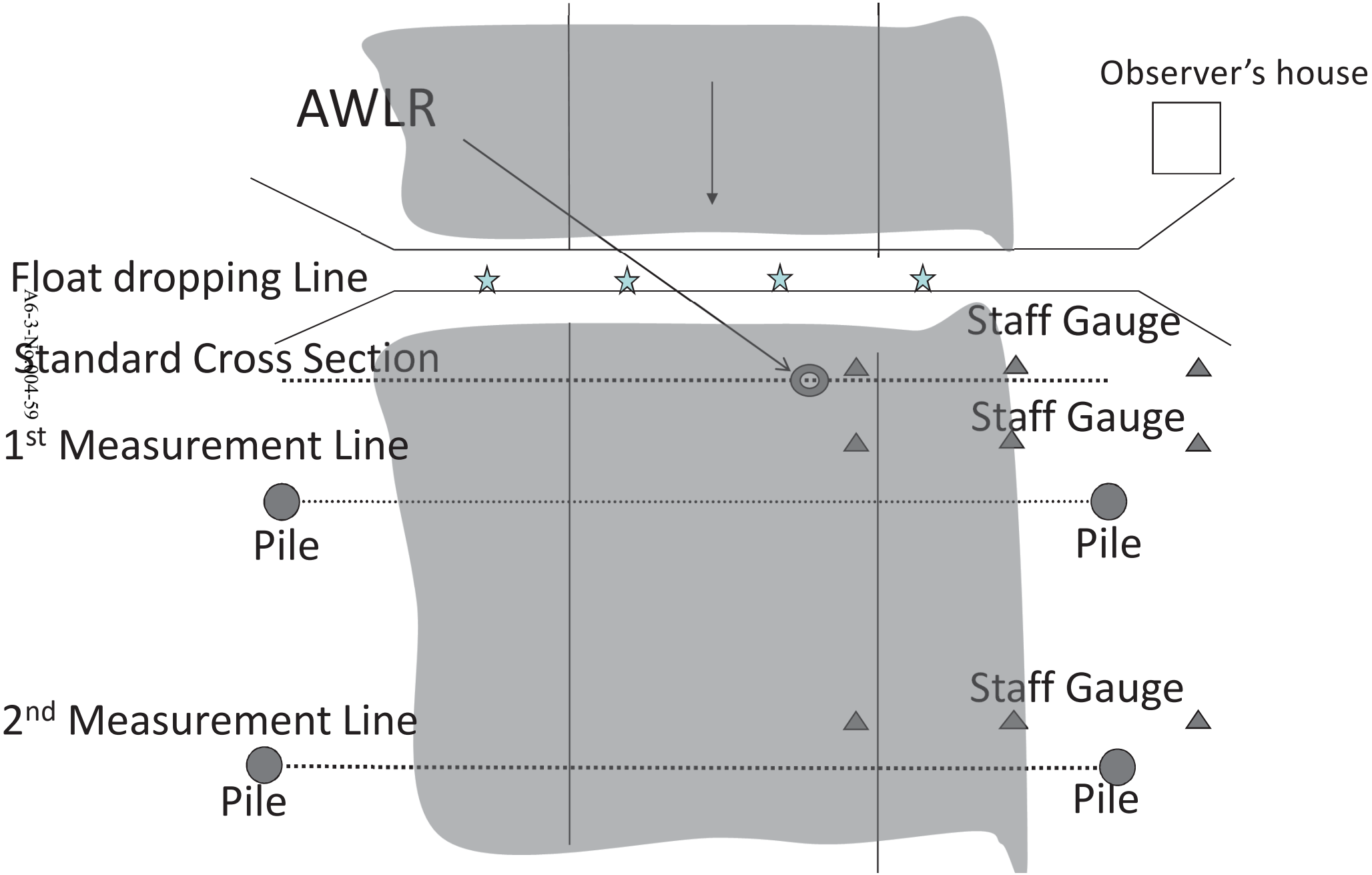
Before measurement, Cross Section Drawings and Float Table should be prepared



A6-3-No.004-58

Facility for High Water Flow Measurement



A6-3-No.004-59

Procedure of Flow Measurement

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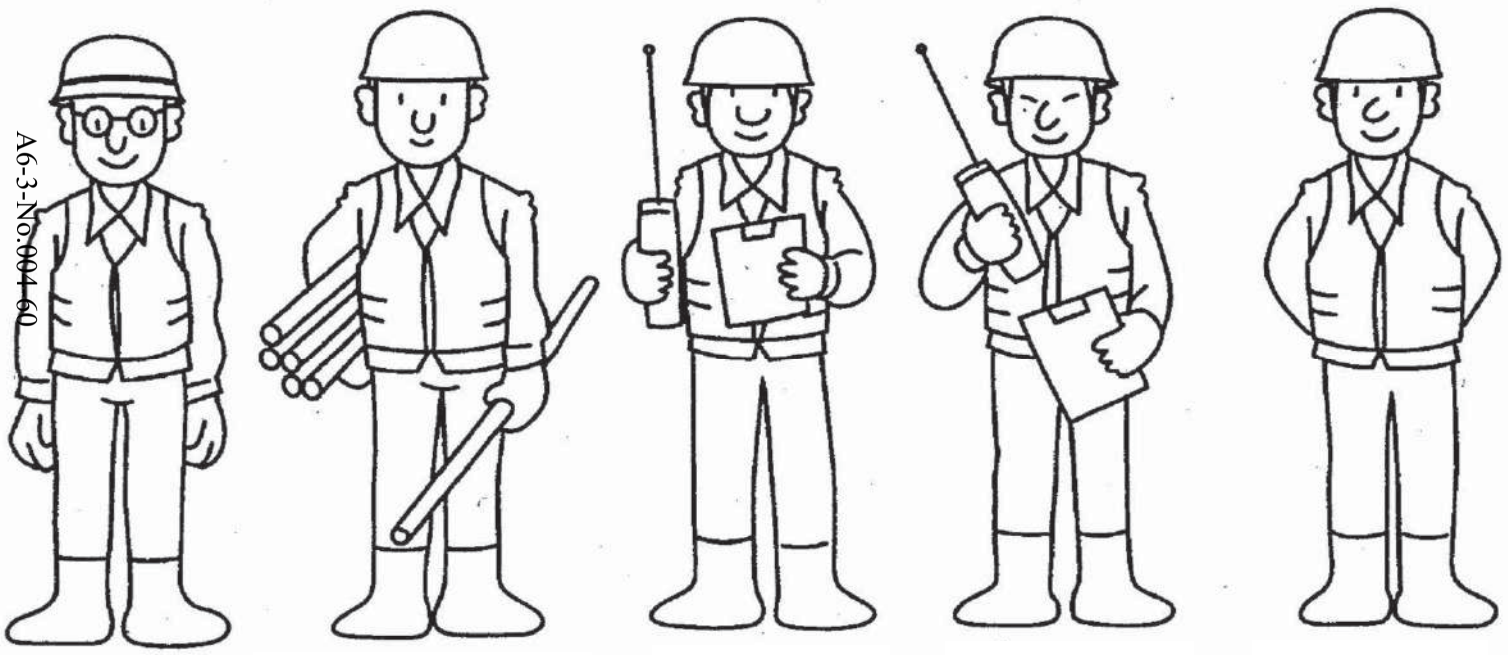
Member of the Group



Leader | Float Thrower | Observer at 1st line | Observer at 2nd line | Observer of Water Level

A6-3-No.004-60

Leader

Leadership and management for measurement and safety for member.
Judgement and direction of float dropping and float flowing
Checking measurement data and calculated data

Float Thrower

dropping float into river and recording time of dropping and situation of float flowing

Observer at measurement line

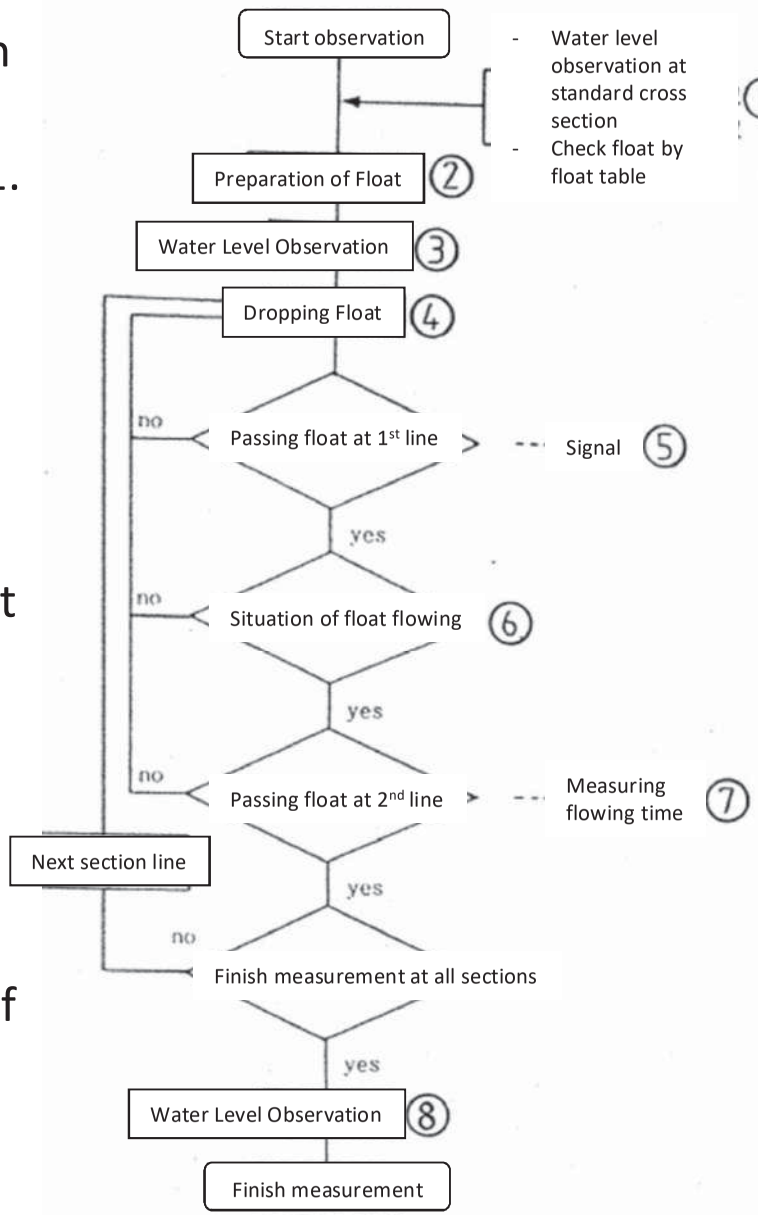
At 1st measurement line, sending sign at moment of passing float at the line and recording water level at staff gauge
At 2nd measurement line, measurement of duration of float flowing from 1st line to 2nd line. And recording water level at staff gauge

Observer of water level

Recoding water level at standard cross section. If position of standard cross section is same/near with 1st or 2nd measurement line, the observer can also hold the post of observer at measurement line

Procedure of Flow Measurement

1. **Water level observation**: Observation of water level at standard cross section and decision of float type by water depth and float table
2. **Float distributions**: Preparation floats that are decided by 1. at position of float dropping
3. **Water level observation**: Observation of water level at standard cross section, 1st and 2nd measurement line after all member is ready
4. **Float dropping**: dropping float to enter the water vertically and stable
5. **Passing float at 1st measurement line**: Sending a sign at the moment of passing float at 1st line from observer at 1st line and staring measurement of duration of float flowing. If observer can not see the float, we must throw the float again
6. **Float flowing situation**: If float flow to outside of the float flow section or staying, we must throw the float again
7. **Passing float at 2nd measurement line**: Sending a sign at moment of passing float at 2nd line and measuring duration of float flowing by observer at 2nd line. If observer can not see the float, we must throw the float again
8. **Water Level observation**: Observation of water level as same as 3. after measurement



Flow cart of float method

A6-3-No.004-61

Procedure of Flow Measurement

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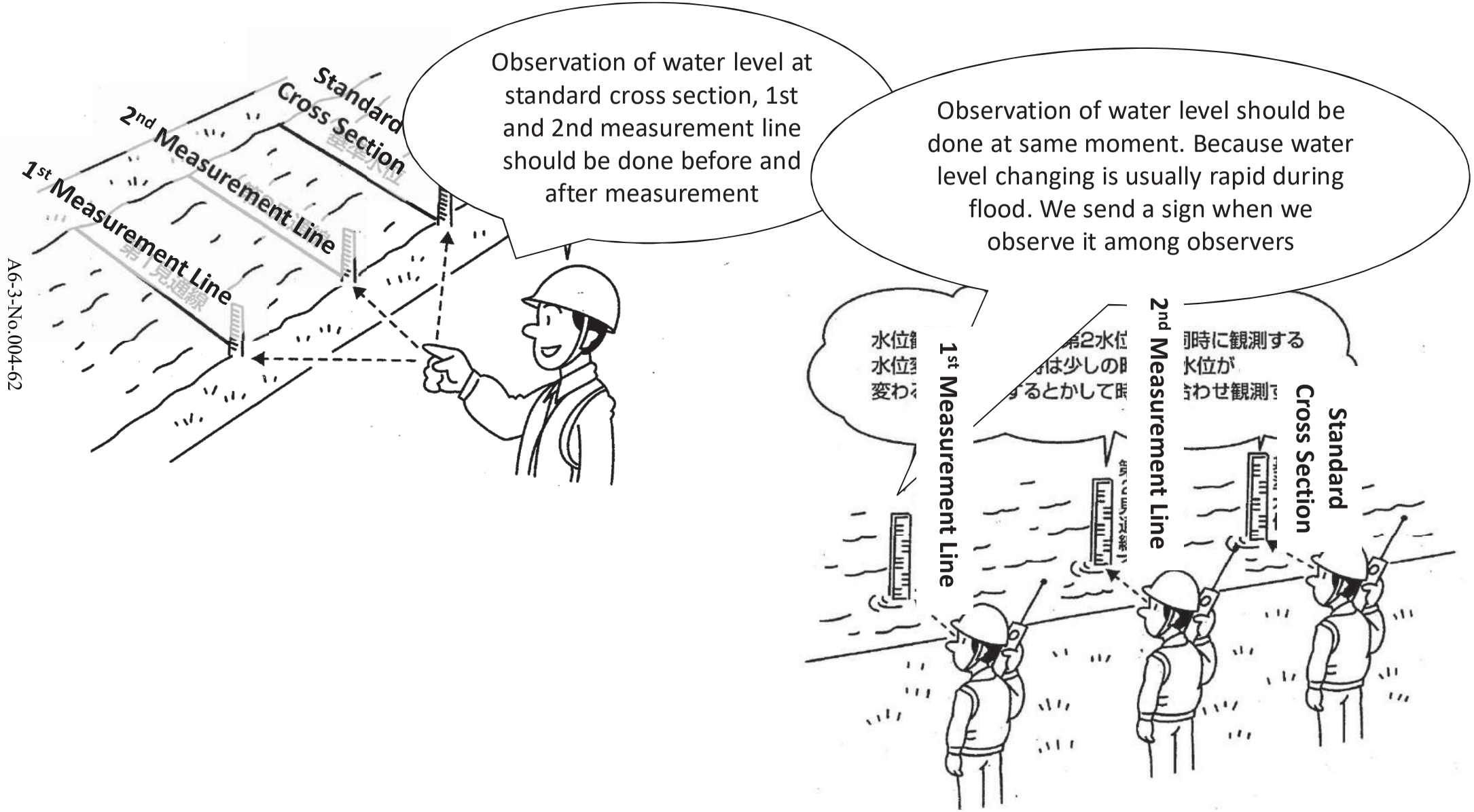
1., 3. Observation of water Level



A6-3-No.004-62

Procedure of Flow Measurement

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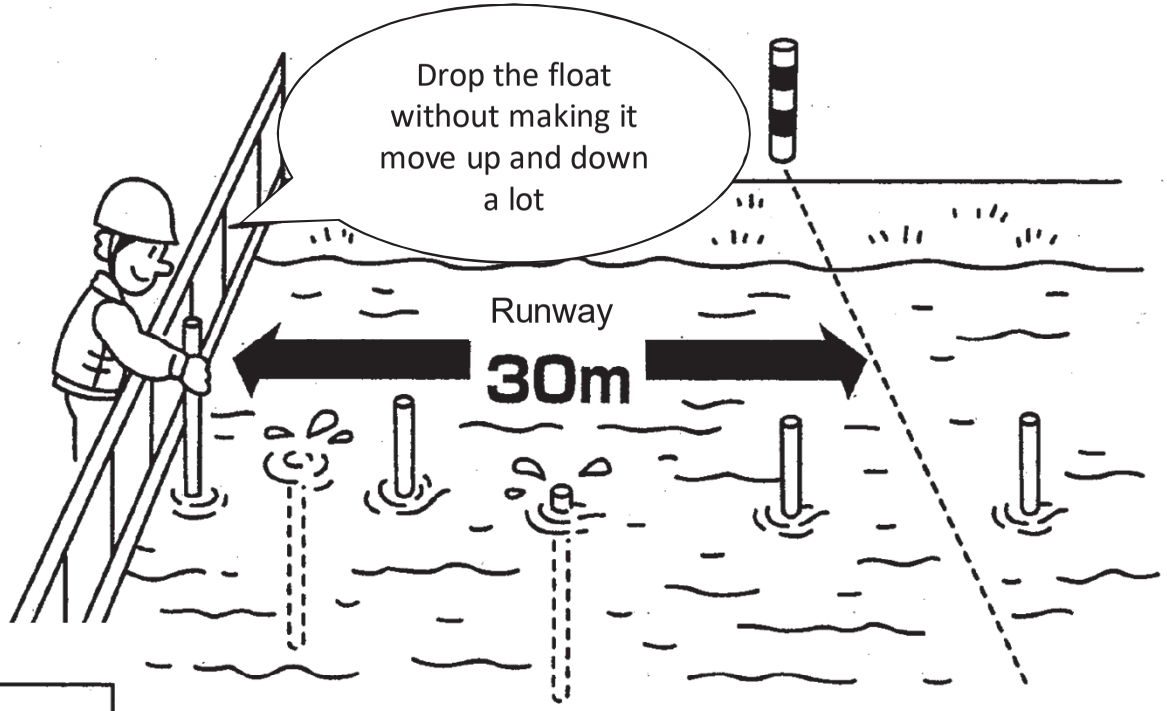
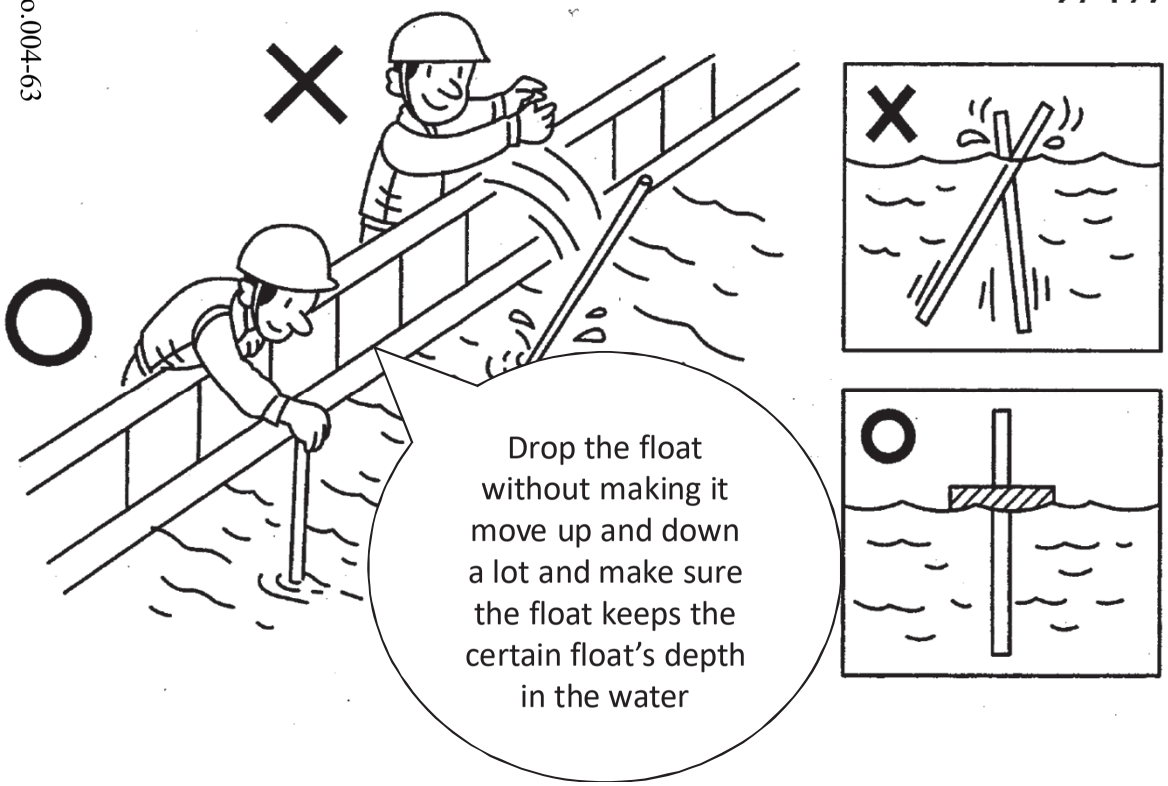
4. Float dropping





A6-3-No.004-63

Procedure of Flow Measurement

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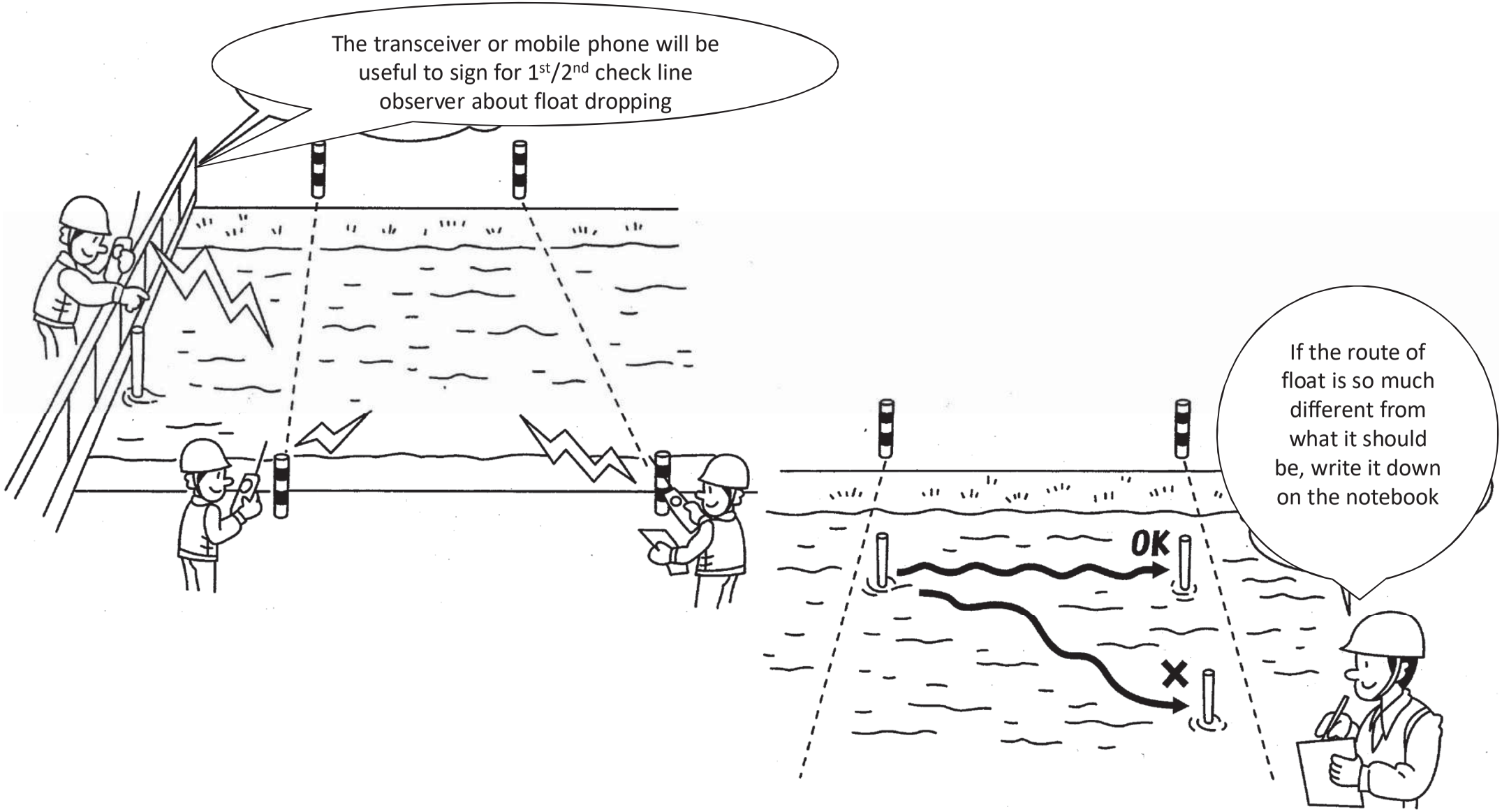
5., 6. Float passes the check line(point)



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Procedure of Flow Measurement

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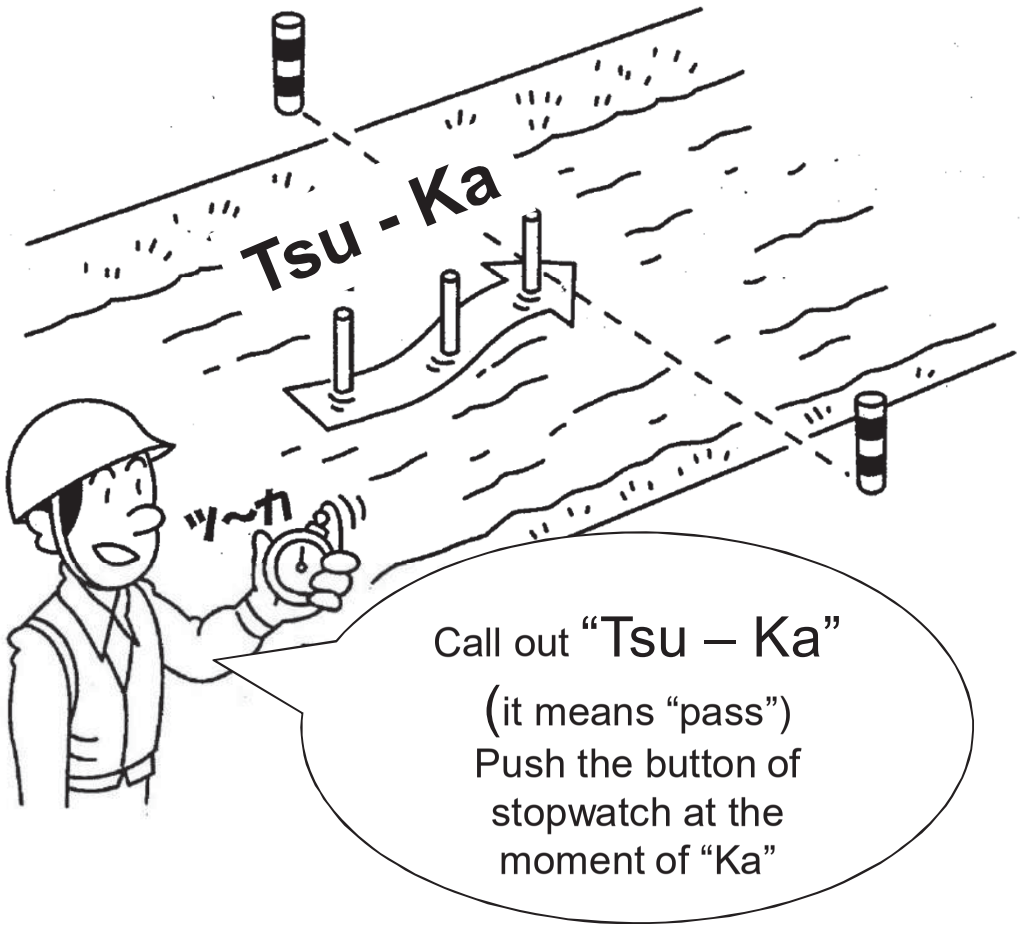
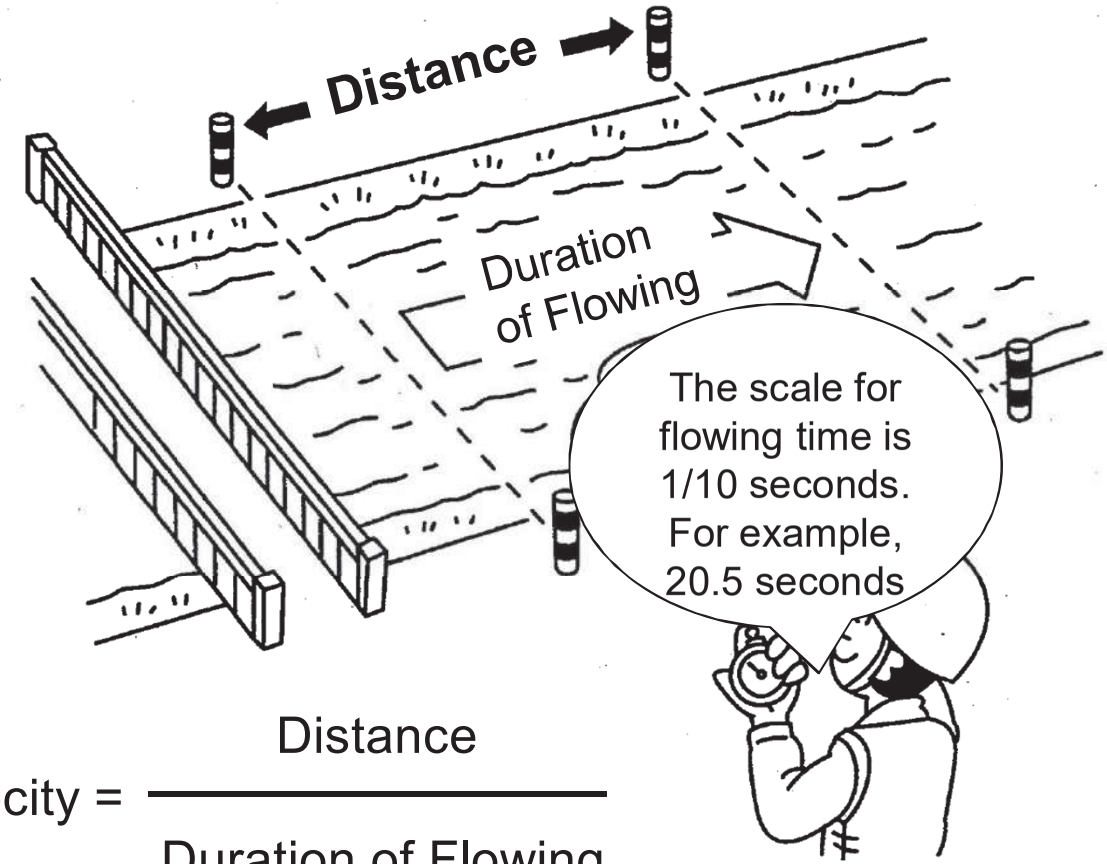
7. Float passed the check line (point)





$$\text{Float Current Velocity} = \frac{\text{Distance}}{\text{Duration of Flowing}}$$

A6-3-No.004-65

Calculation of Flow rate

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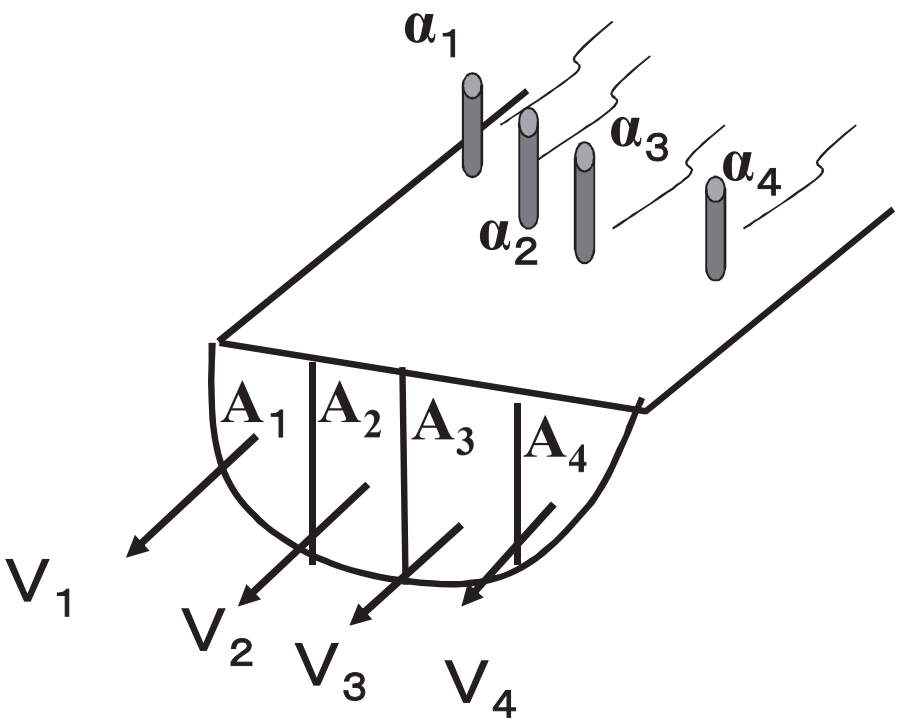
Flow rate Q is calculated
by equation at below



α_i : Coefficient

V_i : Velocity

A_i : Area of each section

$$Q = \Sigma(\alpha_i \times V_i \times A_i)$$

A6-3-No.004-66

Recording data in the notebook

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Manual of recoding data in the notebook

(1) The notebook should be separated by each flood
(2) We should select your responsibility on the notebook by circle mark, because all observers use same notebook. Therefore, we record your data that you are in charge
(3) Table on recording by observers

	Observation data	Observation time	Weather	Observation time	Number of check line	Number	Float depth in the water	Float dropping time	Float passing time	Duration of Float Flowing	Float flowing situation	Water level
Leader	○	○	○								○	
Float handler	○	○		○	○	○	○	○			○	
Observer at 1st line	○	○		○	○				○		○	○
Observer at 2nd line	○	○		○	○				○	○	○	○
Observer of Water level	○	○		○								○

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Recording data in the notebook

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観測所名	読み	種別	観測所記号

data	H19.9.7	Weather	雨
		Wind direction	川上
Frequency	第 8 回	Wind Power	弱
Name of Register	Leader / Float / Observer / Water Level	Observation time	Start 5.52
			End 6.20

Section No.	Float Type No.	Float's depth in the water	Time of dropping Time (hour: minute)	Duration of flowing	Situation of float flowing
1	1	表面	5.58	48.91	異常なし
2	1	表面	6.01	54.90	〃
3	3	1.0	6.08	21.88	〃
4	3	1.0	6.12	17.86	〃
5	3	1.0	6.17	47.07	〃

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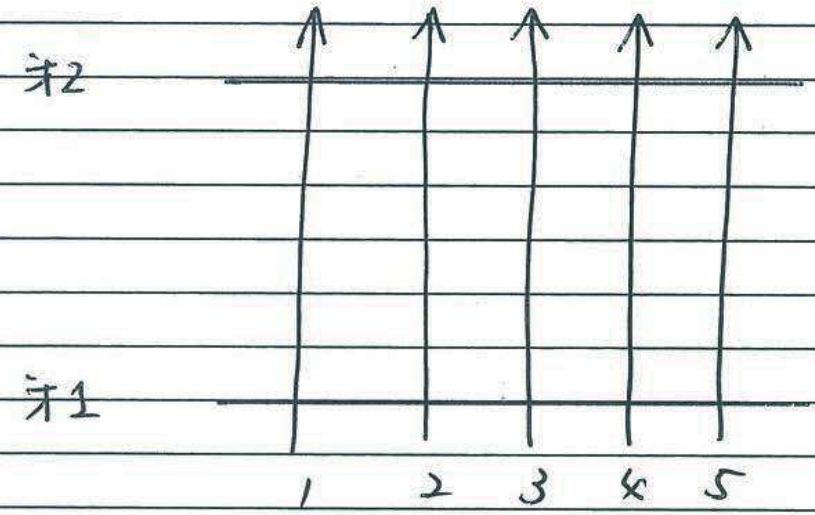
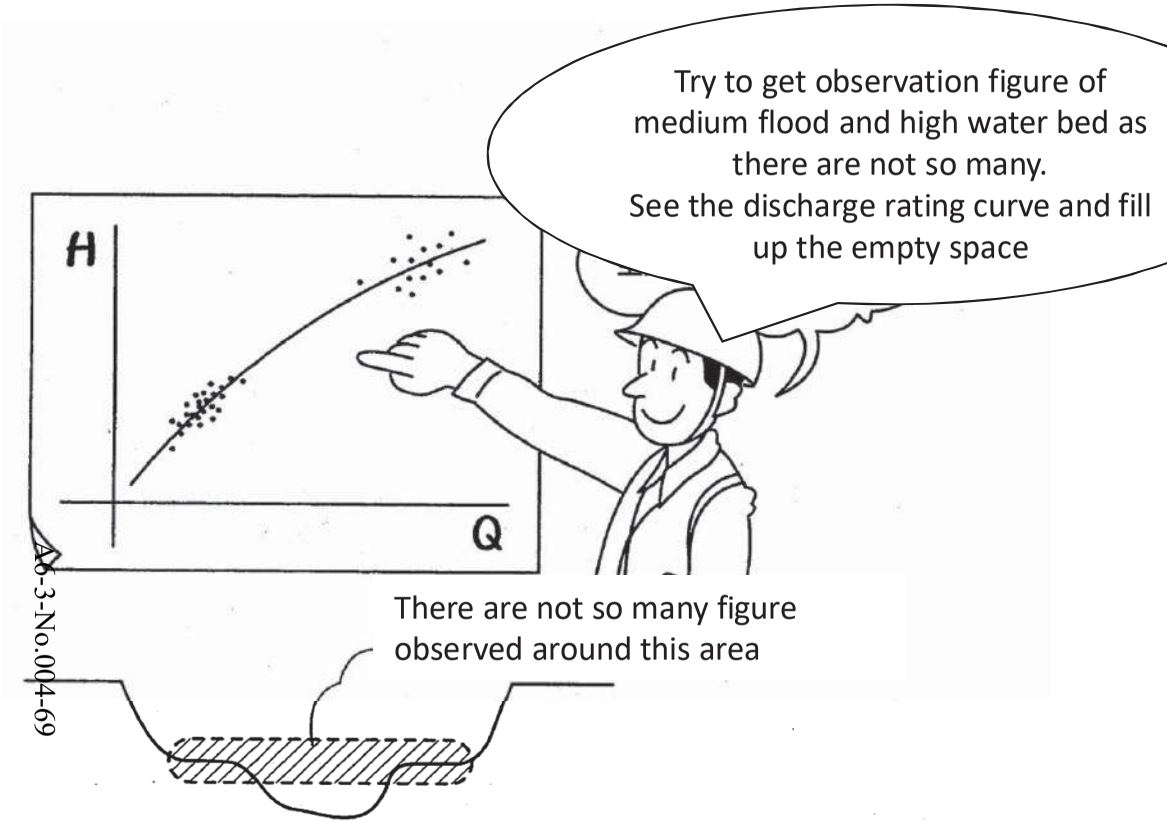
Water Level	Staff Gauge at standard section				Staff Gauge at 1st line				Staff Gauge at 2nd line			
	Time (Hour. Minute)	Water Level (m) Highest	Lowest	Average	Time (Hour. Minute)	Water Level (m) Highest	Lowest	Average	Time (Hour. Minute)	Water Level (m) Highest	Lowest	Average
Start	5.52	3.00	2.94	2.99	5.52	3.37	3.36	3.37	5.52	3.35	3.34	3.35
End	6.20	3.00	2.94	2.99	6.20	3.33	3.33	3.33	6.20	3.33	3.32	3.33
Average	6.06	.	.	2.99	6.06	.	.	3.35	6.06	.	.	3.34

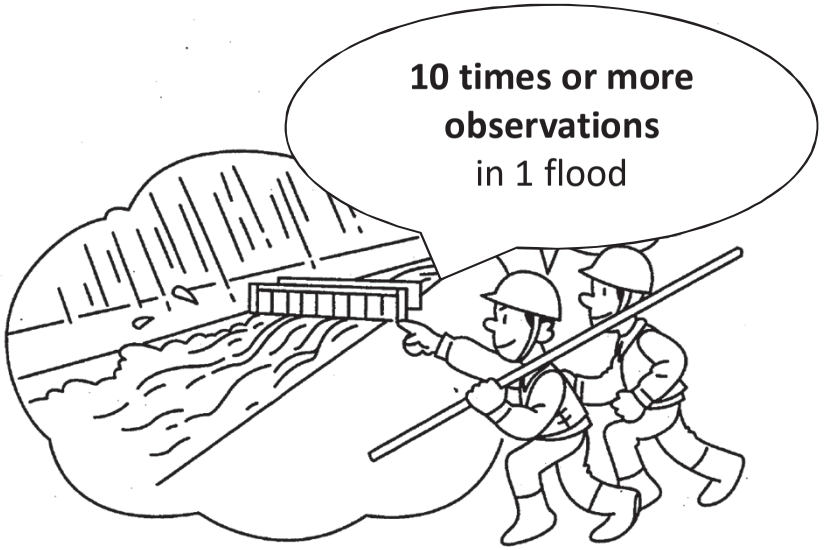
Remarks



観測計画の留意点



A6-3-No.004-69



- Observations should be conducted uniformly during water level increasing and decreasing as much as possible
- We should observed at water level range where there is only fee data as much as possible
- We should observed as many as possible for high accuracy of H-Q curve

Focal Points on Flow Measurement

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Planning and Preparation

- ✓ Availability and maintenance of materials and equipment
- ✓ Creating the Float Table
- ✓ The Group should be consisted of five (5) persons, all person has to have transceiver to share information on observation situation and emergency event

Accuracy Control

- ✓ Periodical survey of reference points and staff gauges at water level station (Every month)
- ✓ Water level observation at each water route in a river where there are several water routes in river channel (relation with existing staff gauge)
- ✓ Taking photos at up and downstream of the station (Every month)
- ✓ Inspection of station site condition just after the flood even the flood is small scale
- ✓ Check the coordinates of flow measurement position (Reconstruction of flow measurement position after flood)
- ✓ Trimming trees and weeding around station and staff gauge as maintenance works (2 times in 1 months in flood season, 1 time in 1 month in other season)

Safety Control

- ✓ Information sharing on dangerous points at the site among observers
- ✓ KY (Risk Prediction) meeting before starting work (dangerous points, maximum/minimum temperature, water level, health condition of observers)
- ✓ Using Hip Boot with spiked shoes (Prevention of slipping down and overturning)
- ✓ Using safety belt for prevention of overturning drown when observer reaches water for water level observation

A6-3-No.004-70

Focal Points on Flow Measurement

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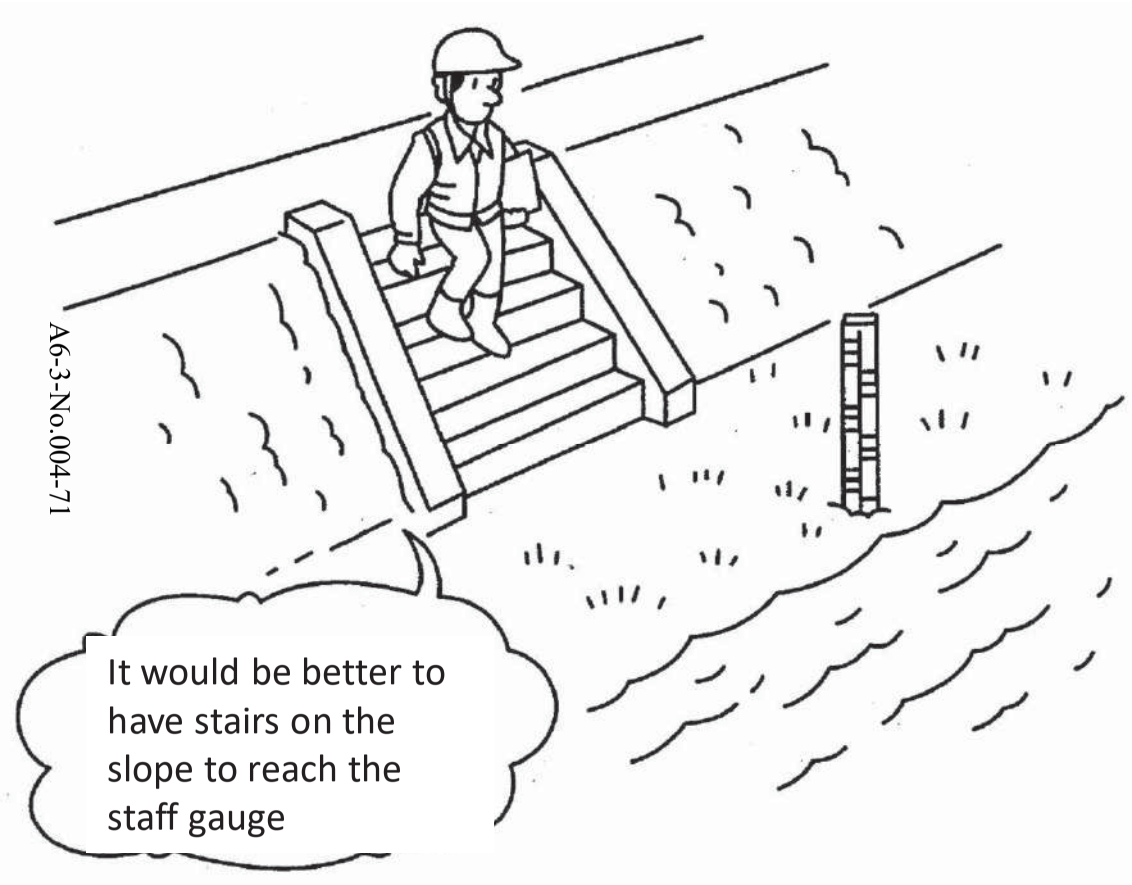
Safety for observation



Avoid risks

Focal Points on Flow Measurement

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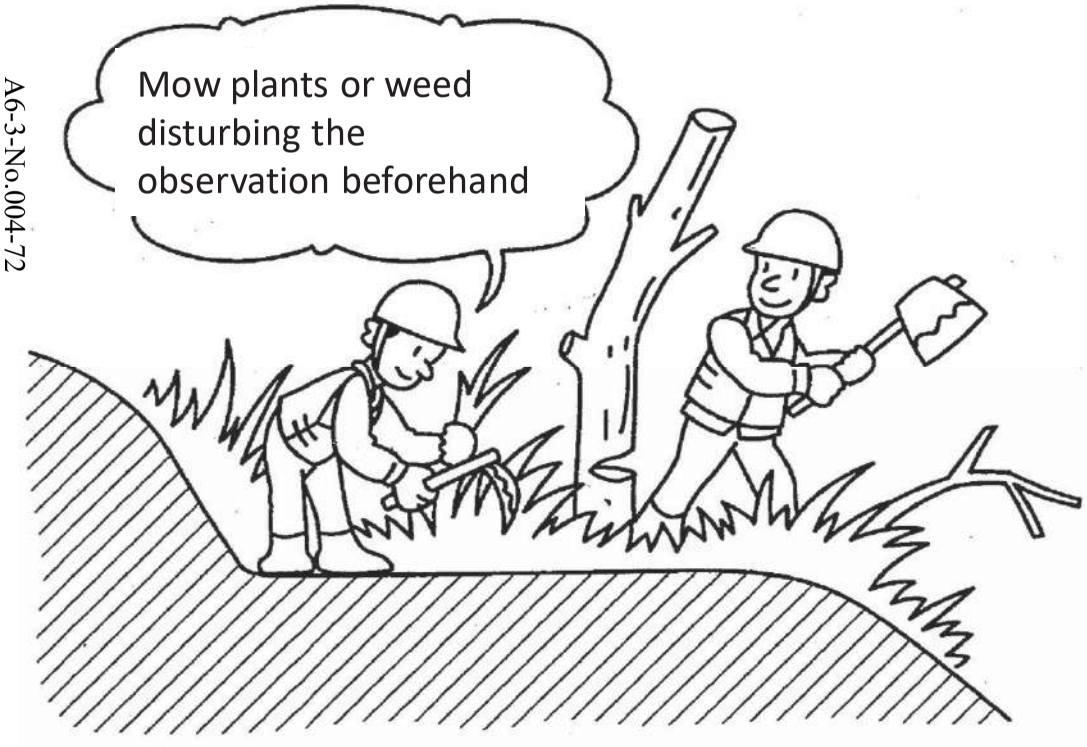
Trimming trees and weeding around station and staff gauge

A6-3-No.004-72



Focal Points on Flow Measurement

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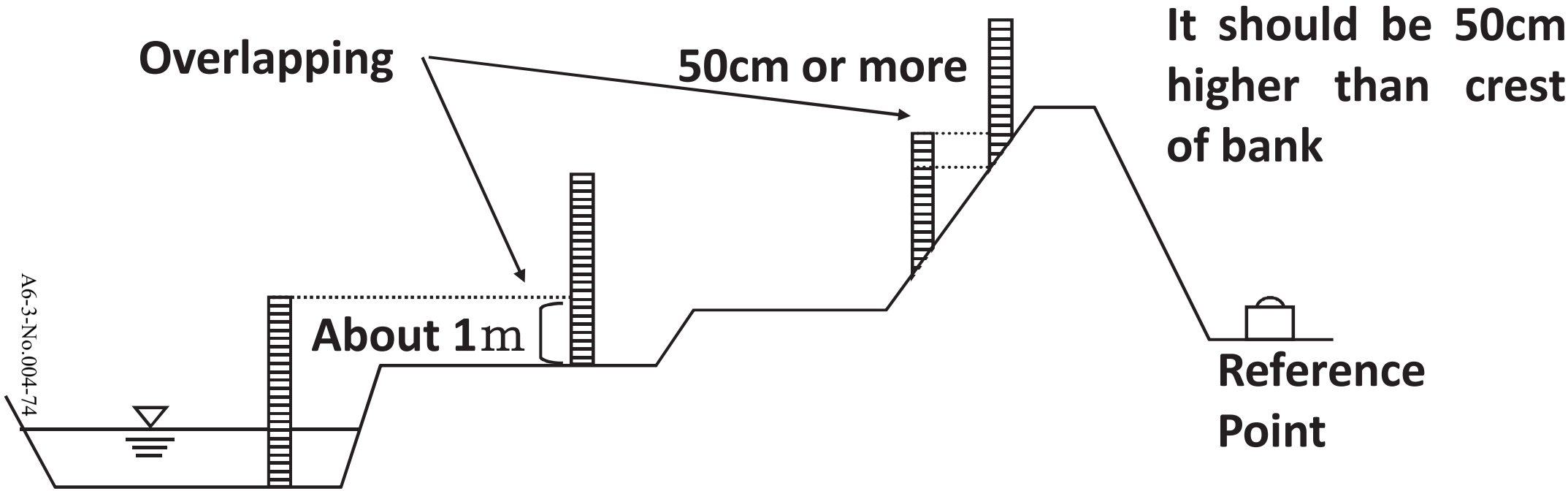
Periodical maintenance of staff gauge

Periodical removal of garbage around staff gauge

A6-3-No.004-73

How to install staff gauge



- Overlapping between upside staff gauges and lower side one should be 50cm higher
- It should be about 50cm higher than crest of bank

3. Calculation of Flow rate and H-Q Curve (How to create H-Q equation)

A6-3-No.004-75

H-Q equation

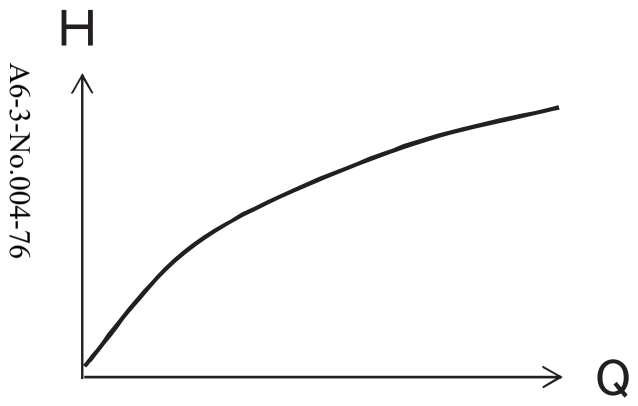


Image of H-Q curve

A6-3-No.004-76

H-Q equation is usually

$$Q = a(H+b)^2$$

expressed like equation above

a and b are coefficient from flow measurement.

Water Level (H) is vertical axis, flow rate (Q) is horizontal axis

How to formulate H-Q equation

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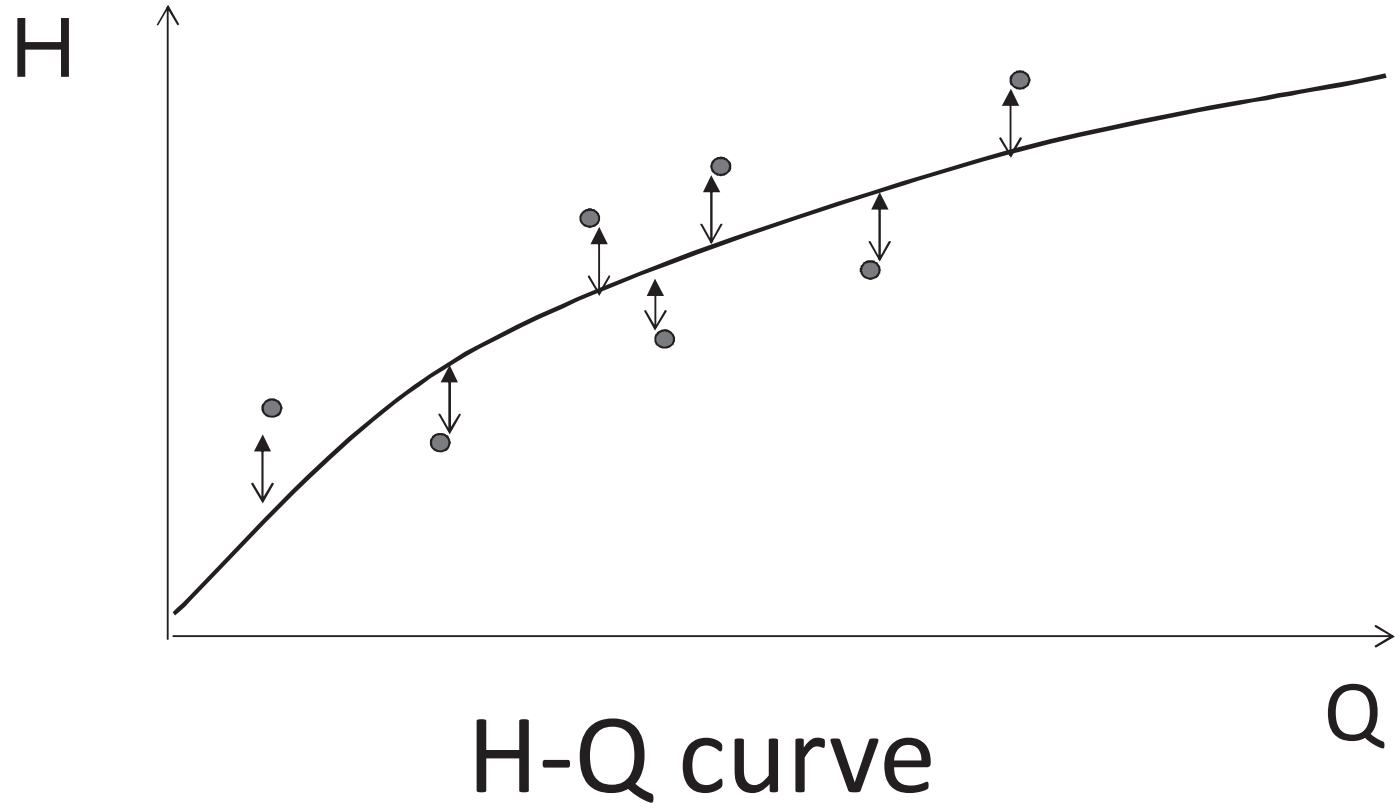
H-Q equation is formulated by least squares method. Least squares method can find a regression line that through nearest distance from all plotted data.

A6-3-No.004-77



Finding a curve that through nearest distance of “ ↕ “

How to formulate H-Q equation

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Firstly, **a'** and **b'** should be calculated from normal equation of least squares method. [ ] is accumulation of each measured value

$$a' = \frac{N[H\sqrt{Q}] - [H]\cdot[\sqrt{Q}]}{N[H^2] - [H]^2}$$

$$b' = \frac{[H^2]\cdot[\sqrt{Q}] - [H][H\cdot\sqrt{Q}]}{N\cdot[H^2] - [H]^2}$$

A6-3-No.004-78

How to formulate H-Q equation

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Calculation from "**a'**"and "**b'**" to "**a**" and "**b**"

$$a = a'^{2} \qquad b = b'/a'$$

$$Q = a(H+b)^2$$

A6-3-No.004-79

How to formulate H-Q equation

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For calculation of a' and b', it should make a table below from water level and flow rate. [ ] is accumulation of each measured value

No.	H(m)	Q（m^3 /s）	H^2	√Q	H√Q
1	1.52	60.3	2.3104	7.7653	11.8033
2	1.63	75.2	2.6569	8.6718	14.1350
Number of observation（N）	[H]	[Q]	[H^2]	[√Q]	[H√Q]

A6-3-No.004-80

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.10	0.10	0.10						
2	0.25	0.10	0.10	0.10	0.06	1.09	1.15			
3	0.50	0.10	0.10	0.10	0.06	1.21	1.30			
4	0.75	0.10	0.10	0.10	0.06	0.36	0.36			
5	1.00	0.08	0.08	0.08						

A6-3-No.004-81

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
1.12	1.12	0.56	0.10	0.25	0.03	0.02
1.26	1.26	1.19	0.10	0.25	0.03	0.04
0.36	0.36	0.81	0.10	0.25	0.03	0.02
		0.18	0.09	0.25	0.02	0.00

Observation No.		1	
Data		15th June 2017	
Observer's Name	Observing		
	Resisting		
Climate	Weather		
	Wind direction		
	Wind Power		
Observation time (hour: minute)	Start	13時 38分	
	End	13時 45分	
	Average	13時 42分	
Water Level (m)		Standard	1st
	Start		
	End		
	Average		
Instrument	Current meter type		
	Calibration type		
	Method	Rot	Walking
	Revolving Number		
Calculating person	Calculation		
	Re-Calculation		
Calculation Result	Total Flow Rate (m3/s)	0.08	
	Total Area of cross section (m2)	0.11	
	Average Velocity (m/s)	0.73	
Water Width (m)		1.00	
Distance from riparian (m)		0.00	
Water Gradient	Distance (m)	Upstream (m)	Downstream (m)	Difference (m)
Remarks				

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.08	0.08	0.08						
2	0.25	0.10	0.10	0.10	0.06	1.08	1.08			
3	0.50	0.09	0.09	0.09	0.05	1.36	1.36			
4	0.75	0.08	0.08	0.08	0.05	0.93	0.94			
5	1.00	0.08	0.08	0.08						

A6-3-No.004-82

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
1.08	1.08	0.54	0.09	0.25	0.02	0.01
1.36	1.36	1.22	0.10	0.25	0.03	0.04
0.94	0.94	1.15	0.09	0.25	0.02	0.02
		0.47	0.08	0.25	0.02	0.01

Observation No.		2		
Data		18th July 2017		
Observer's Name	Observing			
	Resisting			
Climate	Weather			
	Wind direction			
	Wind Power			
Observation time (hour: minute)	Start	10時 31分		
	End	10時 36分		
	Average	10時 34分		
Water Level (m)		Standard	1st	
	Start			
	End			
	Average			
Instrument	Current meter type			
	Calibration type			
	Method	Rot	Walking	
	Revolving Number			
Calculating person	Calculation			
	Re-Calculation			
Calculation Result	Total Flow Rate (m3/s)	0.08		
	Total Area of cross section (m2)	0.09		
	Average Velocity (m/s)	0.89		
Water Width (m)		1.00		
Distance from riparian (m)		0.00		
Water Gradient	Distance (m)	Upstream (m)	Downstream (m)	Difference (m)
Remarks				

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.19	0.19	0.19						
2	0.25	0.19	0.19	0.19	0.11	0.83	0.86			
3	0.50	0.21	0.21	0.21	0.13	1.08	1.08			
4	0.75	0.22	0.22	0.22	0.13	1.25	1.26			
5	1.00	0.23	0.23	0.23						

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
0.85	0.85	0.43	0.19	0.25	0.05	0.02
1.08	1.08	0.97	0.20	0.25	0.05	0.05
1.26	1.26	1.17	0.22	0.25	0.06	0.07
		0.63	0.23	0.25	0.06	0.04

Observation No.		3		
Data		17th Aug. 2017		
Observer's Name	Observing			
	Resisting			
Climate	Weather			
	Wind direction			
	Wind Power			
Observation time (hour: minute)	Start	13時 35分		
	End	13時 42分		
	Average	13時 39分		
Water Level (m)		Standard	1st	
	Start			
	End			
	Average			
Instrument	Current meter type			
	Calibration type			
	Method	Rot	Walking	
	Revolving Number			
Calculating person	Calculation			
	Re-Calculation			
Calculation Result	Total Flow Rate (m3/s)	0.18		
	Total Area of cross section (m2)	0.22		
	Average Velocity (m/s)	0.82		
Water Width (m)		1.00		
Distance from riparian (m)		0.00		
Water Gradient	Distance (m)	Upstream (m)	Downstream (m)	Difference (m)
Remarks				

A6-3-No.004-83

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.07	0.07	0.07						
2	0.25	0.07	0.07	0.07	0.04	1.08	1.09			
3	0.50	0.08	0.08	0.08	0.05	1.34	1.35			
4	0.75	0.07	0.07	0.07	0.04	0.73	0.73			
5	1.00	0.07	0.07	0.07						

A6-3-No.004-84

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
1.09	1.09	0.55	0.07	0.25	0.02	0.01
1.35	1.35	1.22	0.08	0.25	0.02	0.02
0.73	0.73	1.04	0.08	0.25	0.02	0.02
		0.37	0.07	0.25	0.02	0.01

Observation No.		4	
Data		15th Sep. 2017	
Observer's Name	Observing		
	Resisting		
Climate	Weather		
	Wind direction		
	Wind Power		
Observation time (hour: minute)	Start	9時 46分	
	End	9時 50分	
	Average	9時 48分	
Water Level (m)		Standard	1st
	Start		
	End		
	Average		
Instrument	Current meter type		
	Calibration type		
	Method	Rot	Walking
	Revolving Number		
Calculating person	Calculation		
	Re-Calculation		
Calculation Result	Total Flow Rate (m3/s)	0.06	
	Total Area of cross section (m2)	0.08	
	Average Velocity (m/s)	0.75	
Water Width (m)		1.00	
Distance from riparian (m)		0.00	
Water Gradient	Distance (m)	Upstream (m)	Downstream (m) / Difference (m)
Remarks			

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.11	0.11	0.11						
2	0.25	0.11	0.11	0.11	0.07	1.15	1.15			
3	0.50	0.11	0.11	0.11	0.07	1.22	1.22			
4	0.75	0.11	0.11	0.11	0.07	0.58	0.59			
5	1.00	0.11	0.11	0.11						

A6-3-No.004-85

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
1.15	1.15	0.58	0.11	0.25	0.03	0.02
1.22	1.22	1.19	0.11	0.25	0.03	0.04
0.59	0.59	0.91	0.11	0.25	0.03	0.03
		0.30	0.11	0.25	0.03	0.01

Observation No.		5	
Data		8th Nov. 2017	
Observer's Name	Observing		
	Resisting		
Climate	Weather		
	Wind direction		
	Wind Power		
Observation time (hour: minute)	Start	15時 31分	
	End	15時 42分	
	Average	15時 37分	
Water Level (m)		Standard	1st
	Start		
	End		
	Average		
Instrument	Current meter type		
	Calibration type		
	Method	Rot	Walking
	Revolving Number		
Calculating person	Calculation		
	Re-Calculation		
Calculation Result	Total Flow Rate (m3/s)	0.10	
	Total Area of cross section (m2)	0.12	
	Average Velocity (m/s)	0.83	
Water Width (m)		1.00	
Distance from riparian (m)		0.00	

Water Gradient	Distance (m)	Upstream (m)	Downstream (m)	Difference (m)

Remarks

How to formulate H-Q equation

国土交通省

様式2の1の2

Name of station	Name of station in Hiragana	Type	Code

Outside works

Section No.	Distance From Right bank (m)	Water Level (m) Start	Water Level (m) End	Water Level (m) Average	Current Velocity: Depth of Instrument (m)	Current Velocity at Point (m/s) 1st	2nd	3rd	4th	5th
1	0.00	0.12	0.12	0.12						
2	0.25	0.12	0.12	0.12	0.07	0.95	0.92			
3	0.50	0.12	0.12	0.12	0.07	1.13	1.18			
4	0.75	0.12	0.12	0.12	0.07	0.12	0.10			
5	1.00	0.12	0.12	0.12						

A6-3-No.004-86

Inside works

Current Velocity: At Point (m/s)	Average at Cross section (m/s)	Average (m/s)	Area of cross section: Average Water depth (m)	Width (m)	Area (m)	Flow Rate (m3/s)
0.94	0.94	0.47	0.12	0.25	0.03	0.01
1.16	1.16	1.05	0.12	0.25	0.03	0.03
0.11	0.11	0.64	0.12	0.25	0.03	0.02
		0.06	0.12	0.25	0.03	0.00

Observation No.		6	
Data		15th Nov. 2017	
Observer's Name	Observing		
	Resisting		
Climate	Weather		
	Wind direction		
	Wind Power		
Observation time (hour: minute)	Start	時 分	
	End	時 分	
	Average	0時 00分	
Water Level (m)		Standard	1st
	Start		
	End		
	Average		
Instrument	Current meter type		
	Calibration type		
	Method	Rot	Walking
	Revolving Number		
Calculating person	Calculation		
	Re-Calculation		
Calculation Result	Total Flow Rate (m3/s)	0.06	
	Total Area of cross section (m2)	0.12	
	Average Velocity (m/s)	0.50	
Water Width (m)		1.00	
Distance from riparian (m)		0.00	
Water Gradient	Distance (m)	Upstream (m)	Downstream (m)	Difference (m)
Remarks				

How to formulate H-Q equation

国土交通省

H-Q curve calculation sheet (1)

Curve (1)

$Q = a^2 (H + b/a)^2$

$Q = 1.5129 (H + 0.1301)^2$

From 15th June 2017
To 15th Nov. 2017

Basin		River		Station			
Annual No.	H	H^2	Q	$\sqrt{Q}$	$H\sqrt{Q}$
1	0.100	0.0100	0.080	0.2828	0.0283
2	0.090	0.0081	0.080	0.2828	0.0255
3	0.210	0.0441	0.180	0.4243	0.0891
4	0.070	0.0049	0.060	0.2449	0.0171
5	0.110	0.0121	0.100	0.3162	0.0348
6	0.120	0.0144	0.060	0.2449	0.0294
Total	0.700	0.0936	0.560	1.7959	0.2242

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H-Q curve calculation sheet (2)

Curve (1)

$Q = a^2 (H \pm b/a)^2$

$Q = 1.5129 (H \pm 0.1301)^2$

From 15th June 2017
To 15th Nov. 2017

Basin		River		Station			

$$n \times [H\sqrt{Q}] = 6 \times 0.2242 = 1.3452$$

$$[H] \times [\sqrt{Q}] = 0.700 \times 1.7959 = 1.2571$$

$$n \times [H^2] = 6 \times 0.0936 = 0.5616$$

$$[H]^2 = 0.700^2 = 0.4900$$

$$[H^2] \times [\sqrt{Q}] = 0.0936 \times 1.7959 = 0.1681$$

$$[H] \times [H\sqrt{Q}] = 0.700 \times 0.2242 = 0.1569$$

$$a = \frac{n[H\sqrt{Q}] - [H] \times [\sqrt{Q}]}{n[H^2] - [H]^2} = \frac{1.3452 - 1.2571}{0.5616 - 0.4900} = \frac{0.0881}{0.0716} = 1.23$$

$$b = \frac{[H^2] \times [\sqrt{Q}] - [H] \times [H\sqrt{Q}]}{n[H^2] - [H]^2} = \frac{0.1681 - 0.1569}{0.5616 - 0.4900} = \frac{0.0112}{0.0716} = 0.16$$

$$a^2 = 1.23^2 = 1.5129$$

$$\frac{b}{a} = \frac{0.16}{1.23} = 0.13008130 \fallingdotseq 0.1301$$

$$Q = 1.5129 (H \pm 0.1301)^2$$

N : Frequency of measuring
Q : Flow Rate
H : Water Level
[ ] : Accumulation of measured value (*total of H-Q Curve Calculation Sheet (1))

H-Q curve (Applicable water level range)

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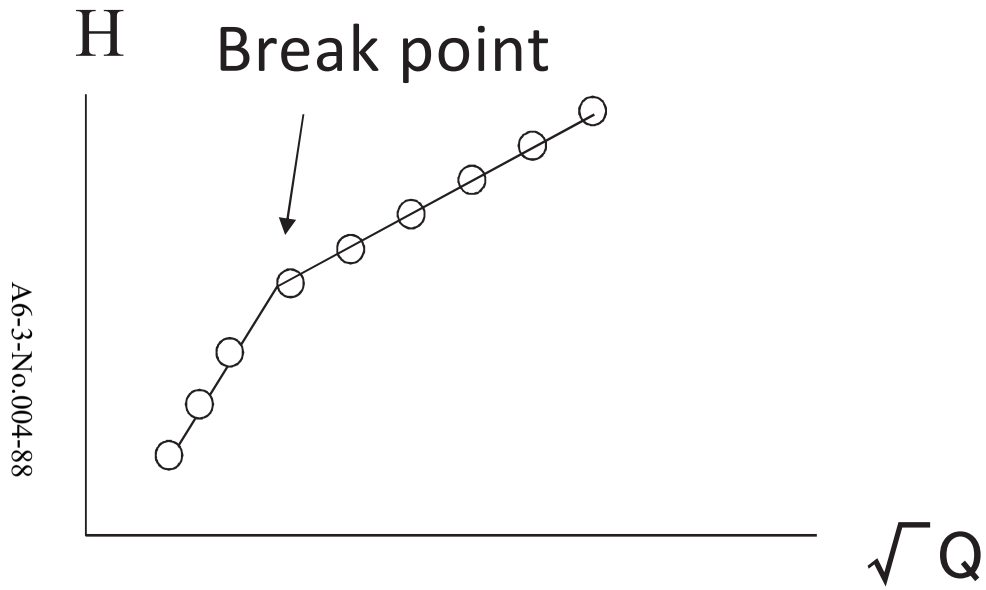

A6-3-No.004-88

It applies H to vertical axis and √Q to horizontal axis. If all plotted data can be on a straight line, it is not necessary to classify applicable water level range.

If plotted data of H—√Q is not straight, it should be classified into two (2) lines, upper one (Middle and high water range) and lower one (low water range)

- Principally, H-Q curve can not apply to range that we have not measured. If highest water level of flow measurement is 6.0m, applicable range is until 6.0m
- It should be checked that applicable water level range is included between highest and lowest water level

H-Q curve (Applicable water level range)

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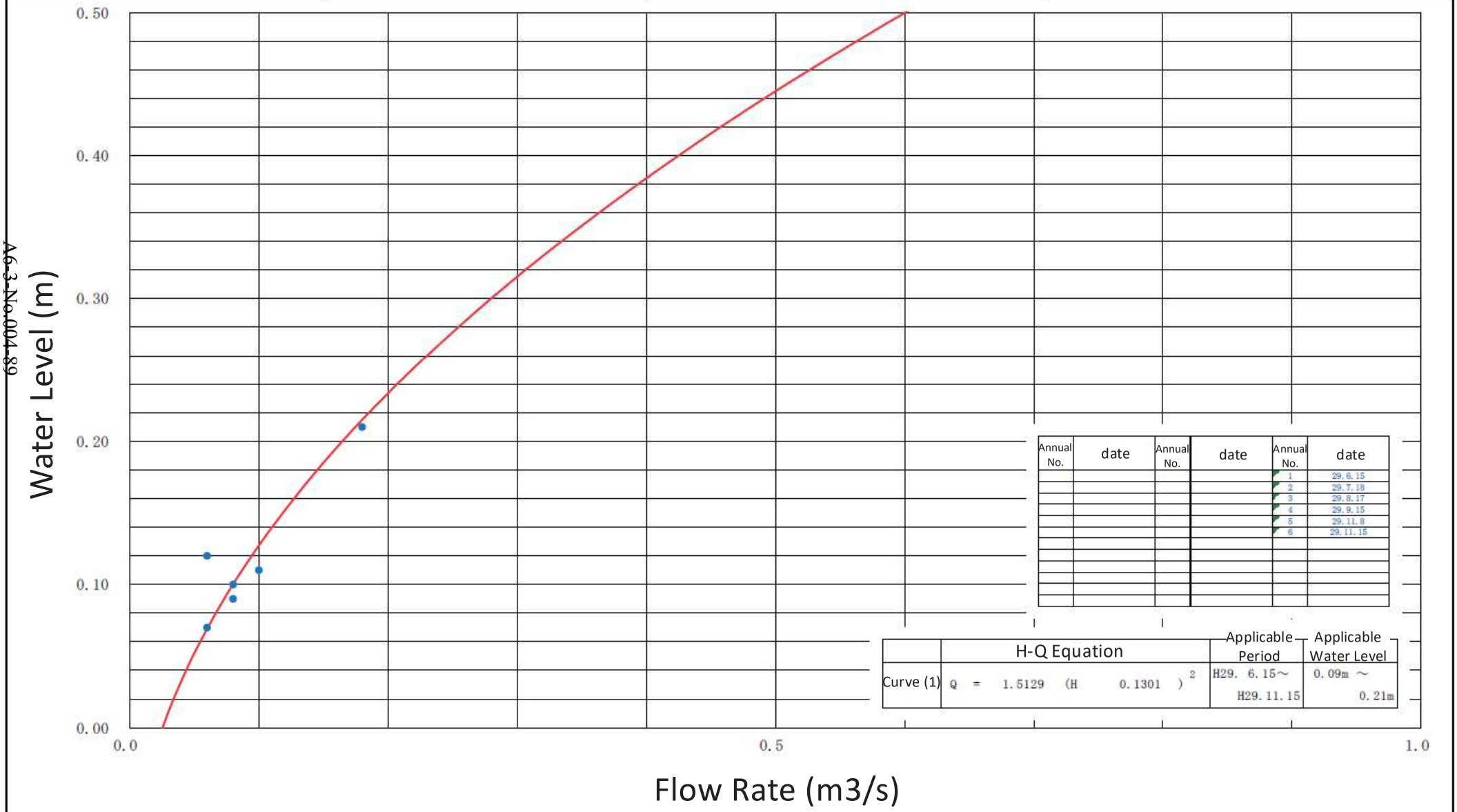
種別	観測所記号

H-Q Curve

$$Q = a^2 (H \pm b/a)^2$$

Basin		River		Station			



Annual No.	date	Annual No.	date	Annual No.	date
				1	29. 6. 15
				2	29. 7. 18
				3	29. 8. 17
				4	29. 9. 15
				5	29. 11. 8
				6	29. 11. 15

	H-Q Equation	Applicable Period	Applicable Water Level
Curve (1)	$Q = 1.5129 (H \quad 0.1301)^2$	H29. 6. 15～ H29. 11. 15	0. 09m ～ 0. 21m

A6-3-No.004-89

Focal point for H-Q equation

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1. H-Q equation can be applied in whole a year, if river cross section is not changed
2. Generally H-Q equation is classified into low water range and middle/high water range. In this case, each equation should be connected（Extrapolation is not acceptable）
3. In case that the equation of low water range is created by only measured data, we should pay attention water level is sometimes lower than applicable range, if water level in drought condition is lower than measured lowest water level (Real water level is in applicable water level range?)

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Data check from H－Q・√Q graph

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Regarding checking abnormal value in measured data, we should check the abnormal value with relations of water level (H) and flow rate (Q) from data distribution conditions of H－Q・√Q graph which we should create

↓

The line of H－√Q graph is usually straight. If some plotted data does not follow the straight line, the data should not be applied

A6-3-No.004-91

H－Q・√Q graph for checking（Example）

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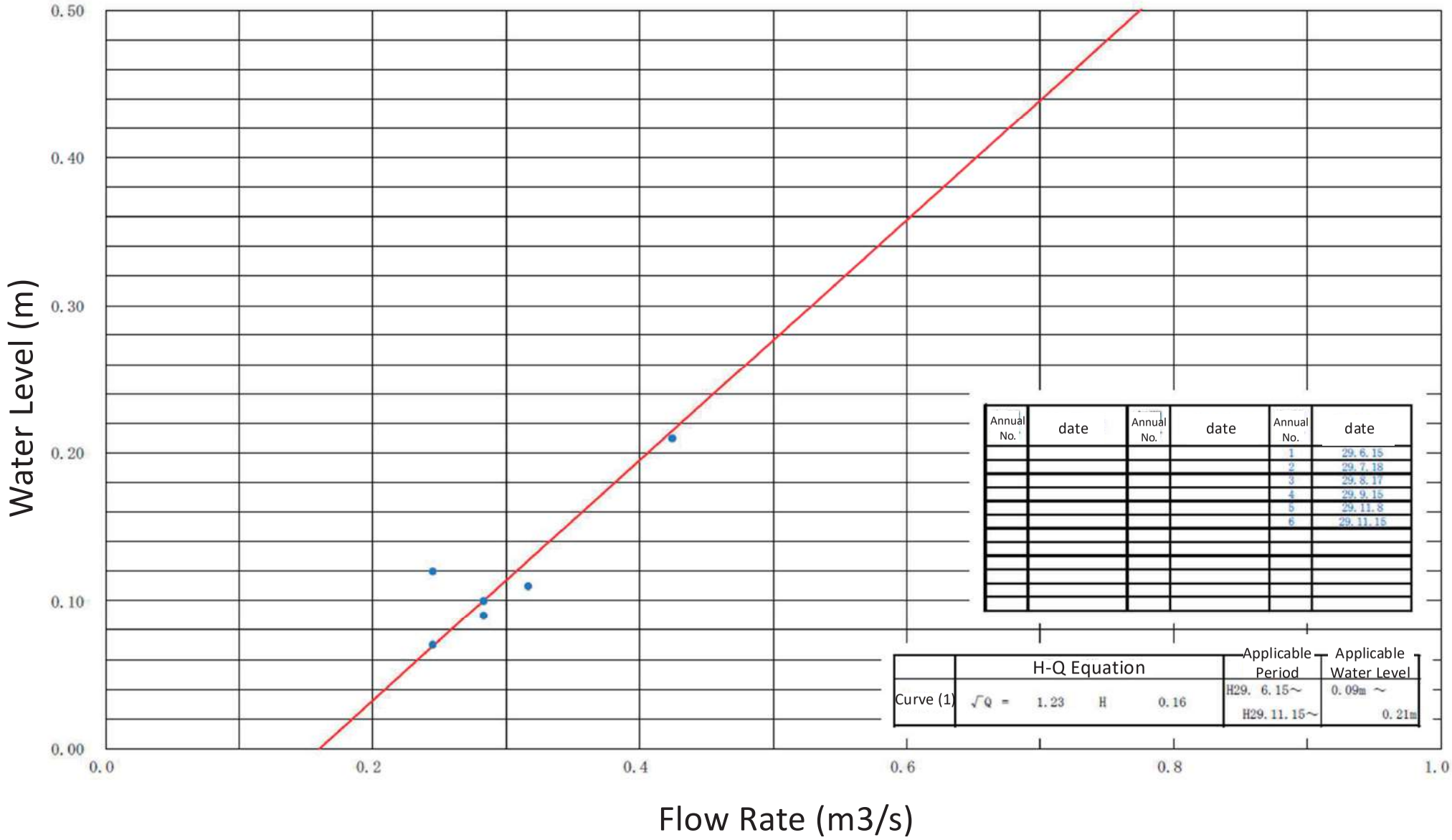
種別	観測所記号

H － √Q 図　　√Q = a H ± b

Basin		River		Station			

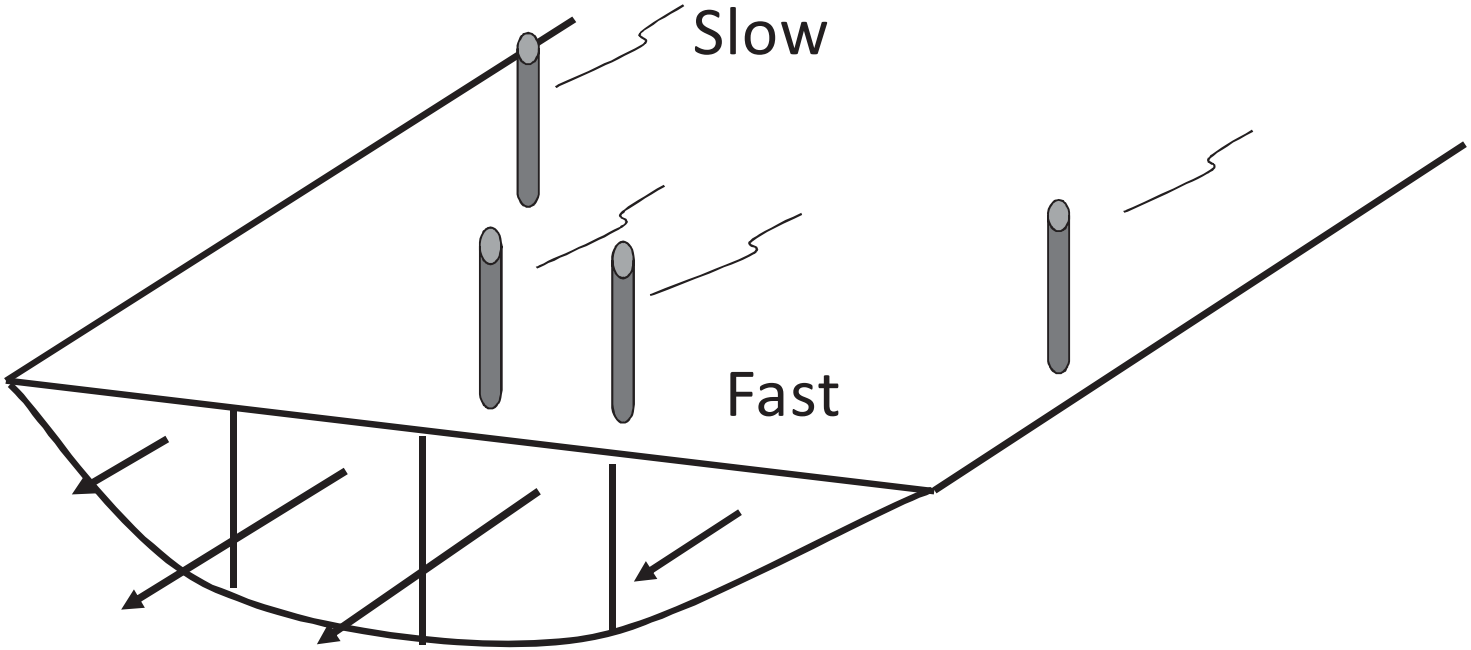


Annual No.	date	Annual No.	date	Annual No.	date
				1	29. 6. 15
				2	29. 7. 18
				3	29. 8. 17
				4	29. 9. 15
				5	29. 11. 8
				6	29. 11. 15

	H-Q Equation	Applicable Period	Applicable Water Level
Curve (1)	√Q = 1.23 H 0.16	H29. 6. 15～ H29. 11. 15～	0.09m ～ 0.21m

A6-3-No.004-92

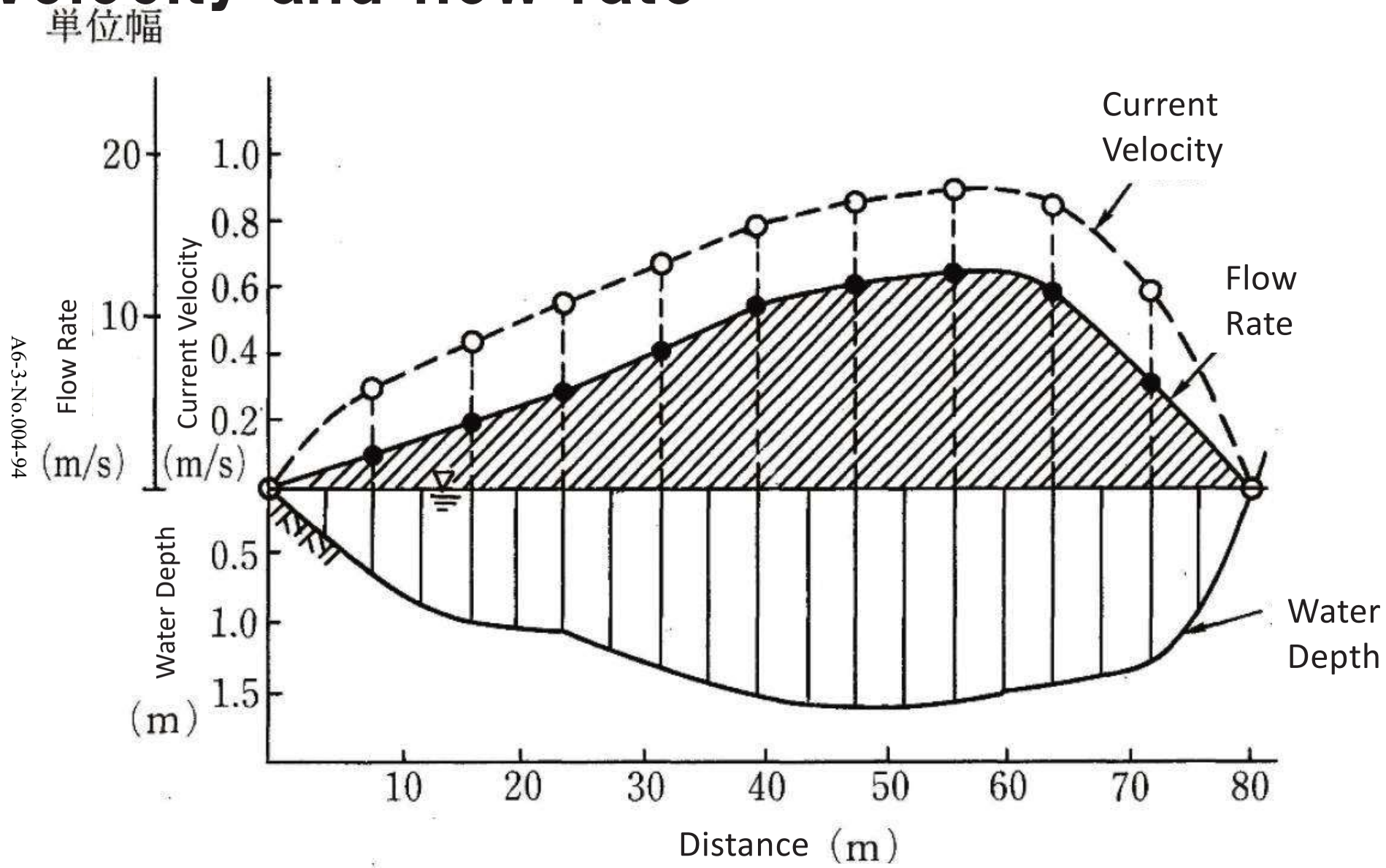
Inspection by Cross Section, current velocity and flow rate



A6-3-No.004-93

- In general, current velocity is fast at line of deep water, slow at line of shallow water
- We can inspect validity of current velocity and flow rate from cross section, velocity and H-Q curve

Inspection by Cross Section, current velocity and flow rate



Cross Section – Current Velocity – H-Q curve

Source: Technical Criteria for River Works, MLIT Japan

ご清聴
ありがとうございました
Terima Kasih

Dam Operation & Maintenance in Japan

Mr. Maruyama Jun

Director of River Management Office, River Environment Division, Water and Disaster Management Bureau, MLIT Japan

Tokuyama Dam (Rock-fill)

Yokogawa Dam(Concrete Gravity)

Kin Dam (Trapezoid-shaped CSG）

Kawaji Dam (Concrete Arch)

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Ministry of Land, Infrastructure, Transport and Tourism

Transition of Number of Dam managed by MLIT

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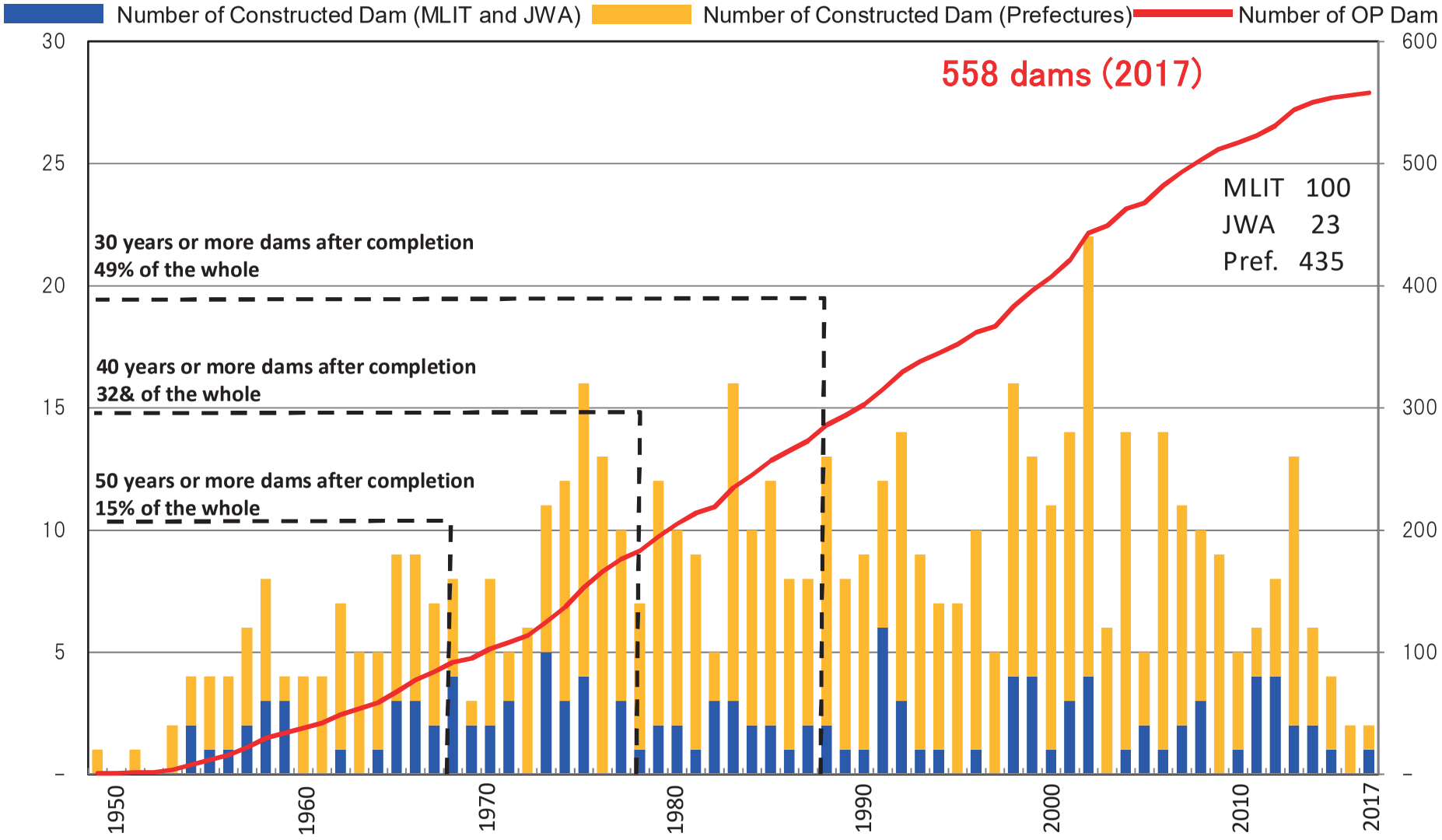
● 558 dams are managed by MLIT, Japan Water Agency (JWA) and Prefectures in Japan (2017)



A6-3-No.004-97

Transition of Dam O/M Budget（MLIT and JWA）

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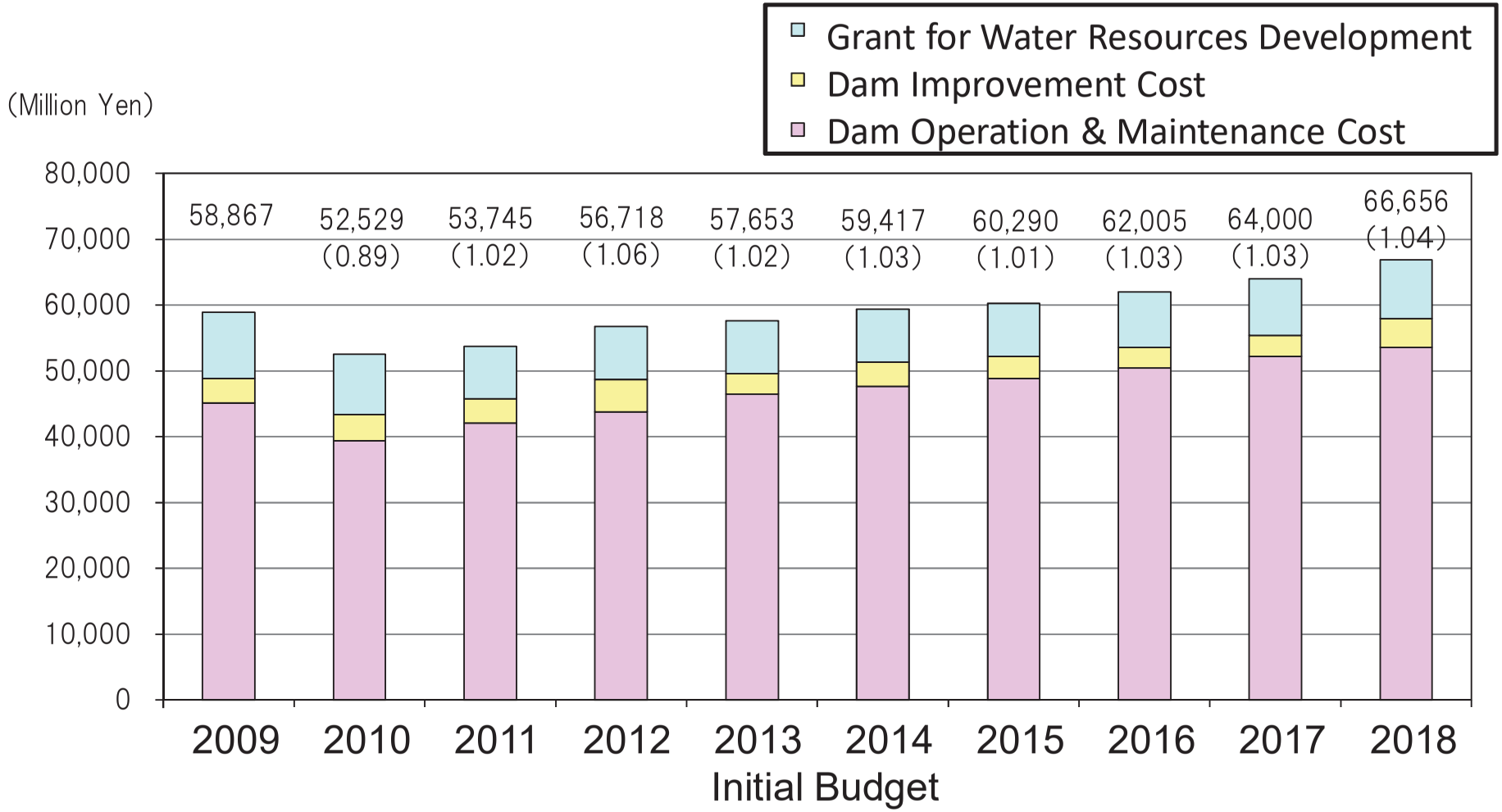

A6-3-No.004-98

Situation of Rainfall in recent years in Japan

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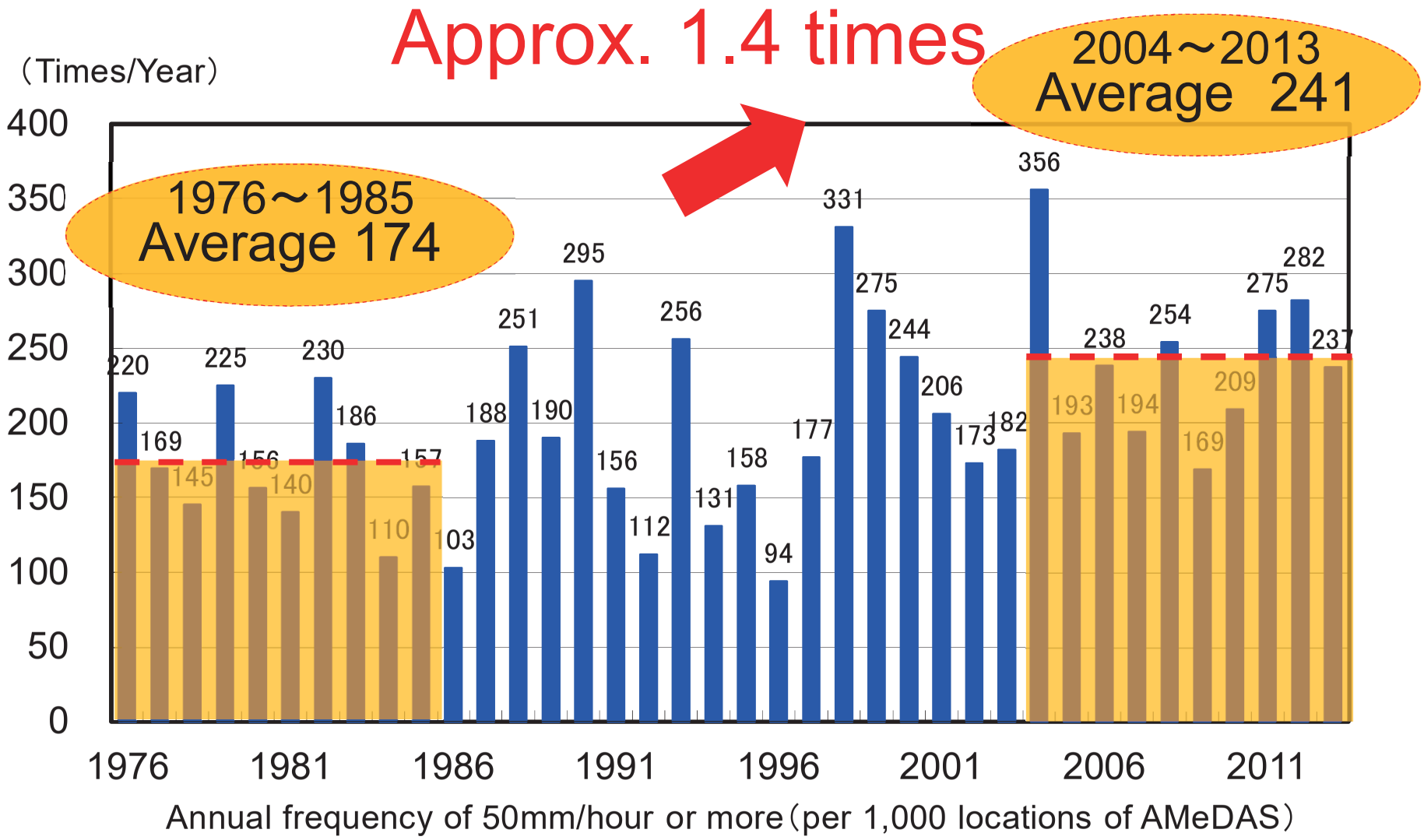
●Increases frequency of short time heavy rain that over 50mm/hour (about 1.4 times of 30 years ago)



Sources: Japan Meteorological Agency

A6-3-No.004-99

Current Condition of Flood Control by Dam

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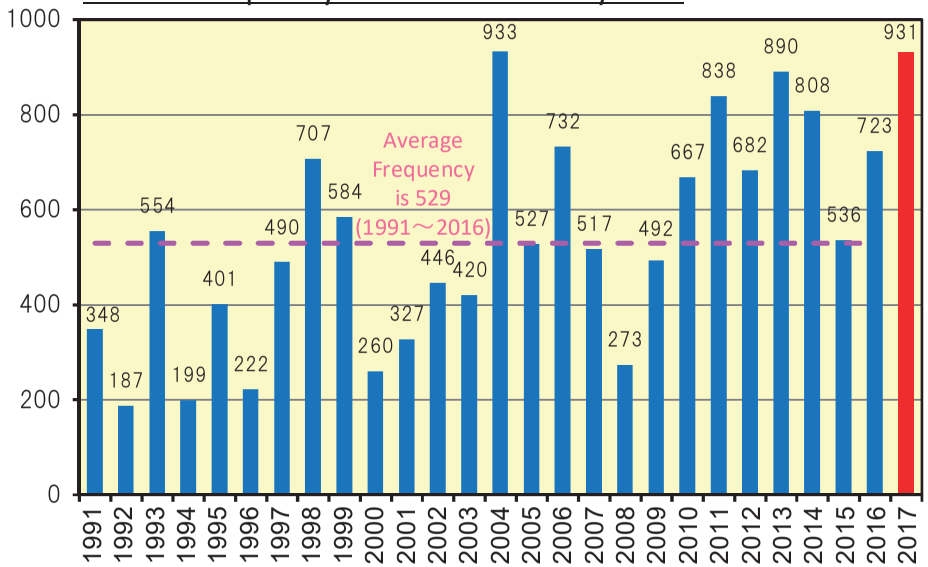
- Due to frequency and scale of water related disaster by influences of climate change, flood Control by Dam had conducted 931 times on 2017. It is the 2nd most frequency in the records.
- Flood Control by Dam contributes effects of flood damage reduction to reduce discharge to the downstream by storage a part of flood water and others
- Frequency of flood control by dams than are managed by MLIT has increased. The frequency is over the average since 2010

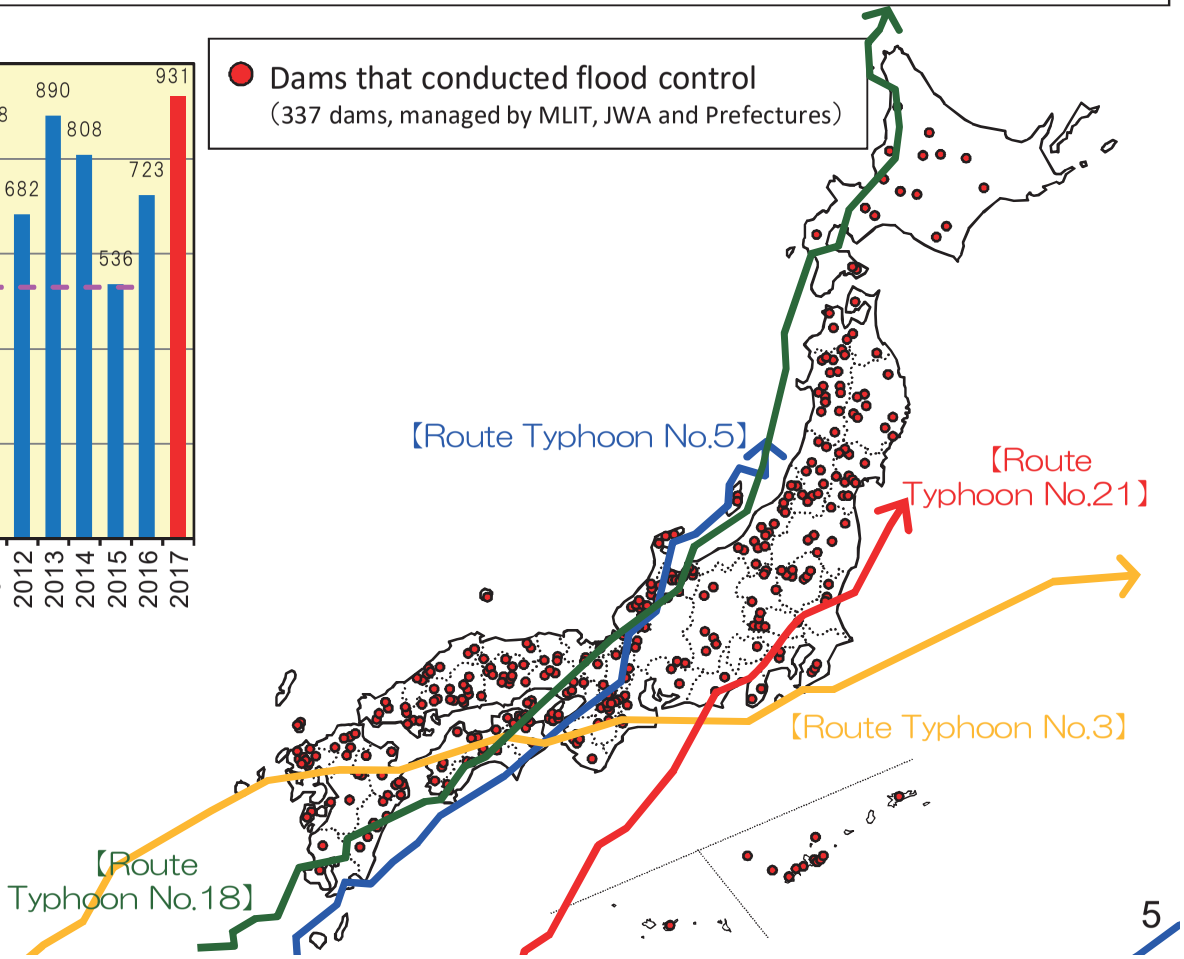
Annual Frequency of Flood Control by Dam



Operation for Abnormal Flood that exceeds planned scale

【2016】
Taki Dam（Iwate Pref.）
Kanayama Dam（Hokkaido Development Bureau）
Daisetsu Dam（Hokkaido Development Bureau）

【H29】
Shichigawa Dam（Wakayama Pref.）
Kitagawa Dam（Oita pref.）
Muromaki Dam（Toyama Pref.）

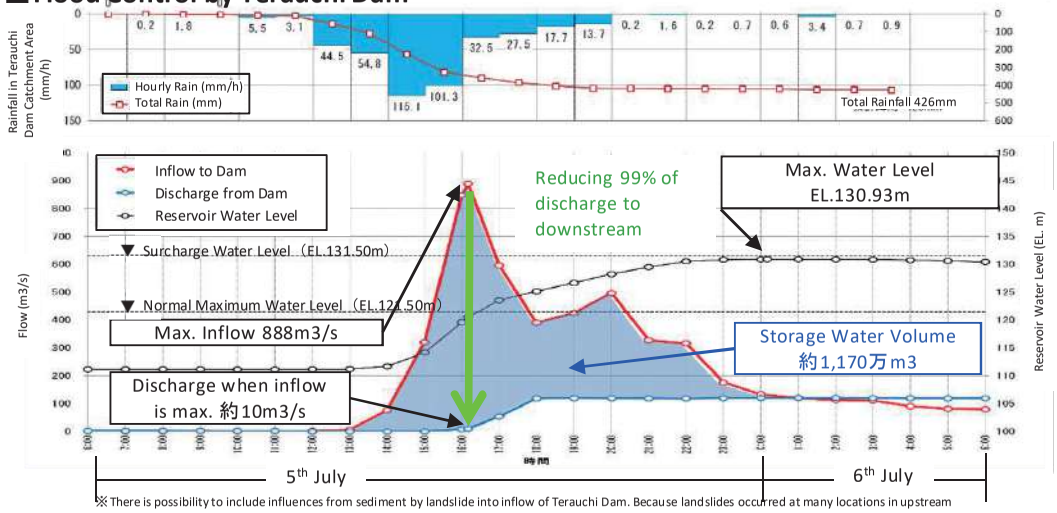


A6-3-No.004-100

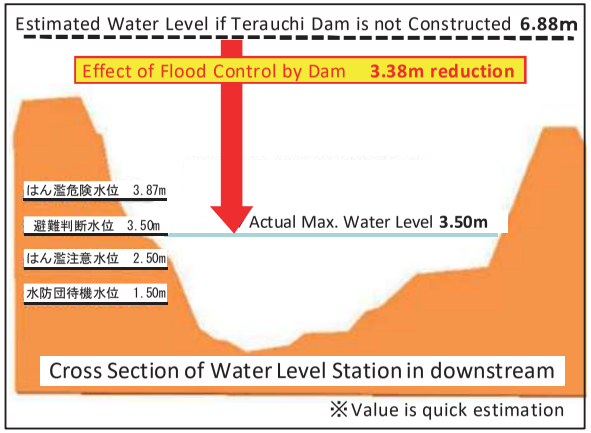
Effects of Flood Control by Terauchi Dam on July 2017

- Torrential rain by seasonal rain front happened on 5ht July 2017 in northern part of Kyusyu region, it made rainfall in total is over 400mm in Sada River Basin. Terauchi Dam recorded a largest inflow since operation started
- Flood control by Terauchi Dam effected reducing downstream water level by 99% reduction of discharge to downstream
- If Terauchi Dam is not constructed, it is estimated that 1,500 Ha and 1,100 houses are inundated in Sada River Basin by overflow from river dike
- Dam reservoir caught lots of drift wood and sediment

■Flood Control by Terauchi Dam



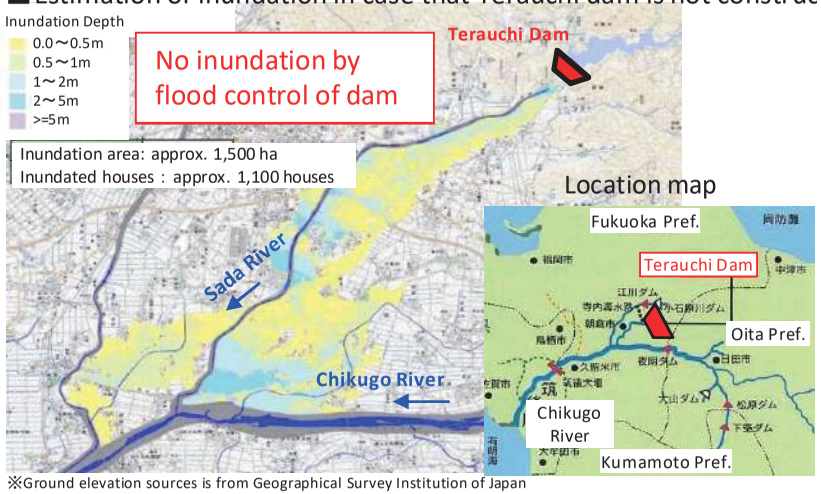
※There is possibility to include influences from sediment by landslide into inflow of Terauchi Dam. Because landslides occurred at many locations in upstream



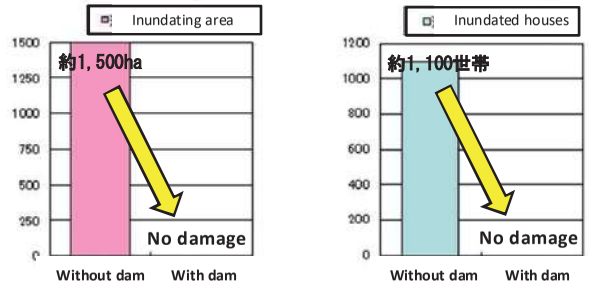
※Value is quick estimation

■Situation of drift wood in reservoir

■Estimation of inundation in case that Terauchi dam is not construc



※Ground elevation sources is from Geographical Survey Institution of Japan
※Inundation depth is estimated by simulation model of river dike overflow
※Inundation area and inundated house considered area of Asakura city and Tachiarai town (Information as of 2010)
※Value is quick estimation. Therefore, there is possibility revising by detail analysis



※Damage in case of "without dam" is estimated by simulation
※There was no damage by overflow in Sada River, therefore case of "with dam" is none damage
※Value is quick estimation. Therefore, there is possibility revising by detail analysis

Dam Operation & Maintenance Works

A6-3-No.004-102

Organization Structure for Dam O/M

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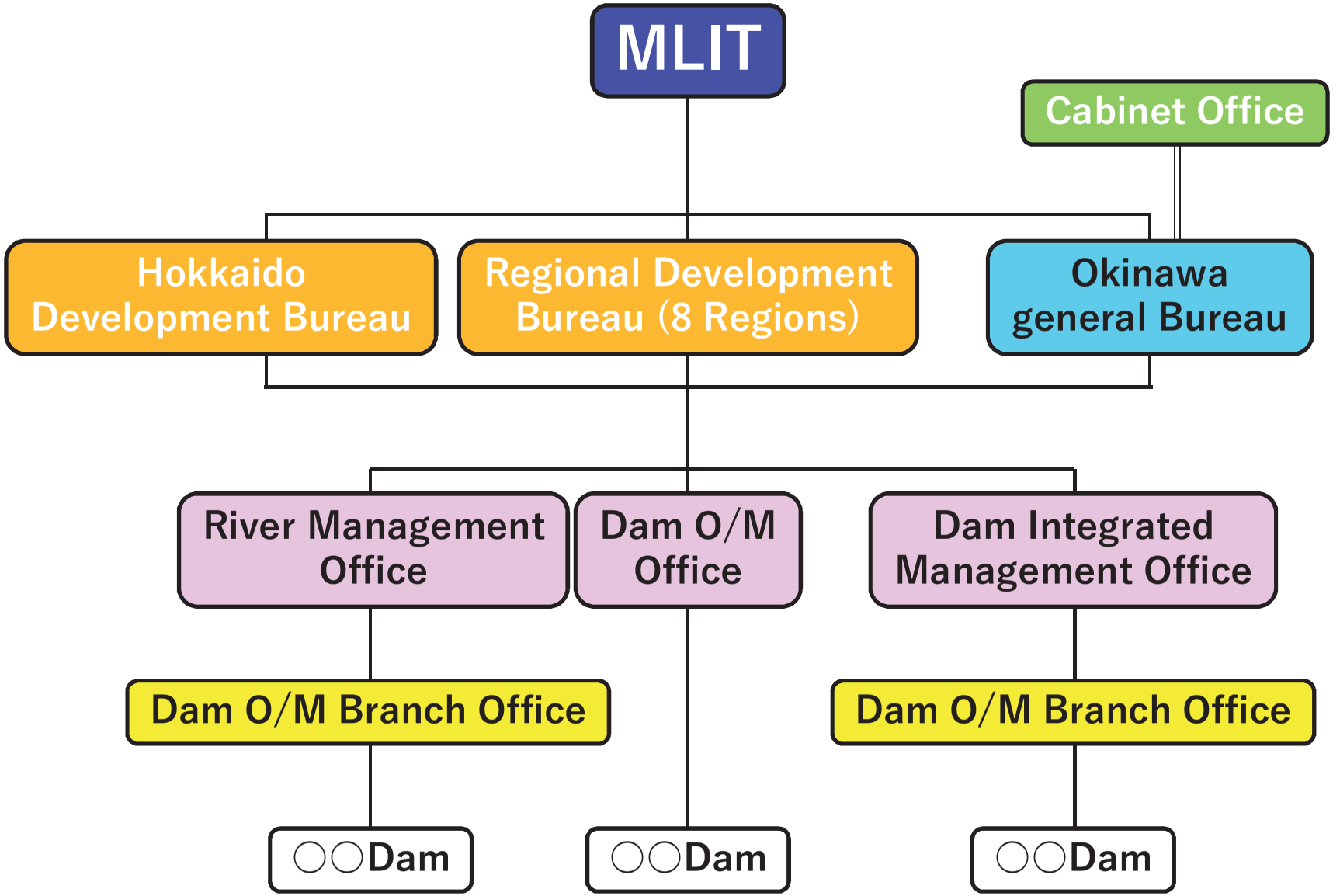

Japan Water Agency（JWA） Incorporated Administrative Agency

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Water Resources Development promotion Law (Law No.217, 13th Nov. 1961)

- MLIT designates prioritized river basins for water resources development (Cabinet Decision)

【River Basins for Water Resources Development】Tone, Arakawa, Toyogawa, Kiso, Yodo, Yoshino and Chikugo River

- MLIT coordinates with Ministries and Governors to formulate Water Resources Development Basic Plan (Cabinet Decision)

Japan Water Agency Law (Law No.182, 18th Dec. 2002)

JWA is in charge of construction, rehabilitation, operation & maintenance of water resources infrastructures, based on Water Resources Development Basic Plan (Article 12, Japan Water Agency Law)

●Tasks of Japan Water Agency

JWA implements stable water supply for regions where need water due to industrial development and concentration of population (3 metropolitan areas (Tokyo, Osaka, Nagoya), Shikou and Kyusyu) through construction, rehabilitation and operation & maintenance of water resources infrastructures

■Construction and rehabilitation of dams and canals

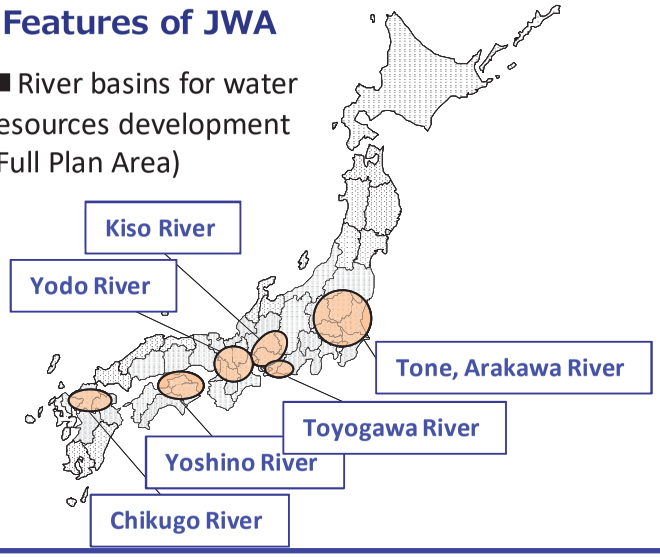
Construction and rehabilitation of dams and canals for water utilization and flood control, based on Water Resources Development Basic Plan that is stipulated in Water Resources Development Promotion Law

■Operation & Maintenance of Dams and Canals

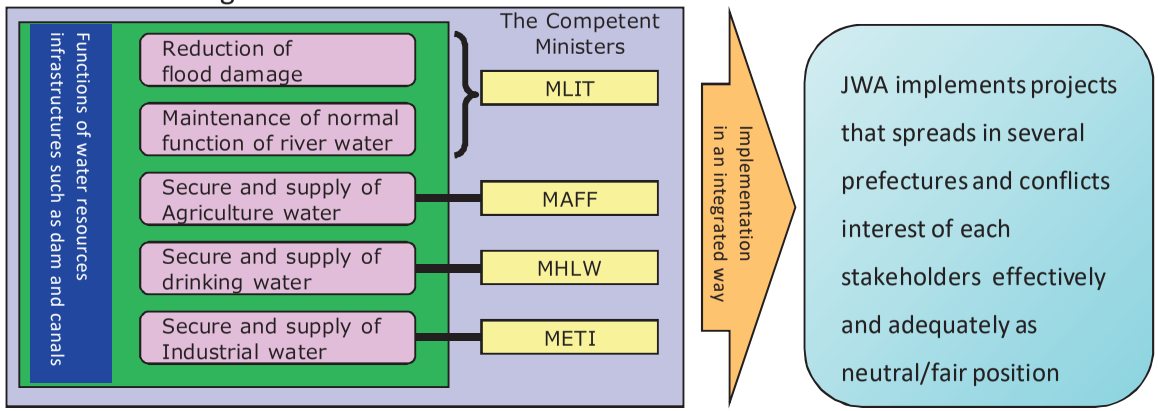
Operation and Maintenance of dams and canals that are constructed based on Water Resources Development Basic Plan that is stipulated in Water Resources Development Promotion Law

●Features of JWA

■River basins for water resources development (Full Plan Area)



■Conducting multipurpose and wide-area works in an integrated way with several ministries and agencies



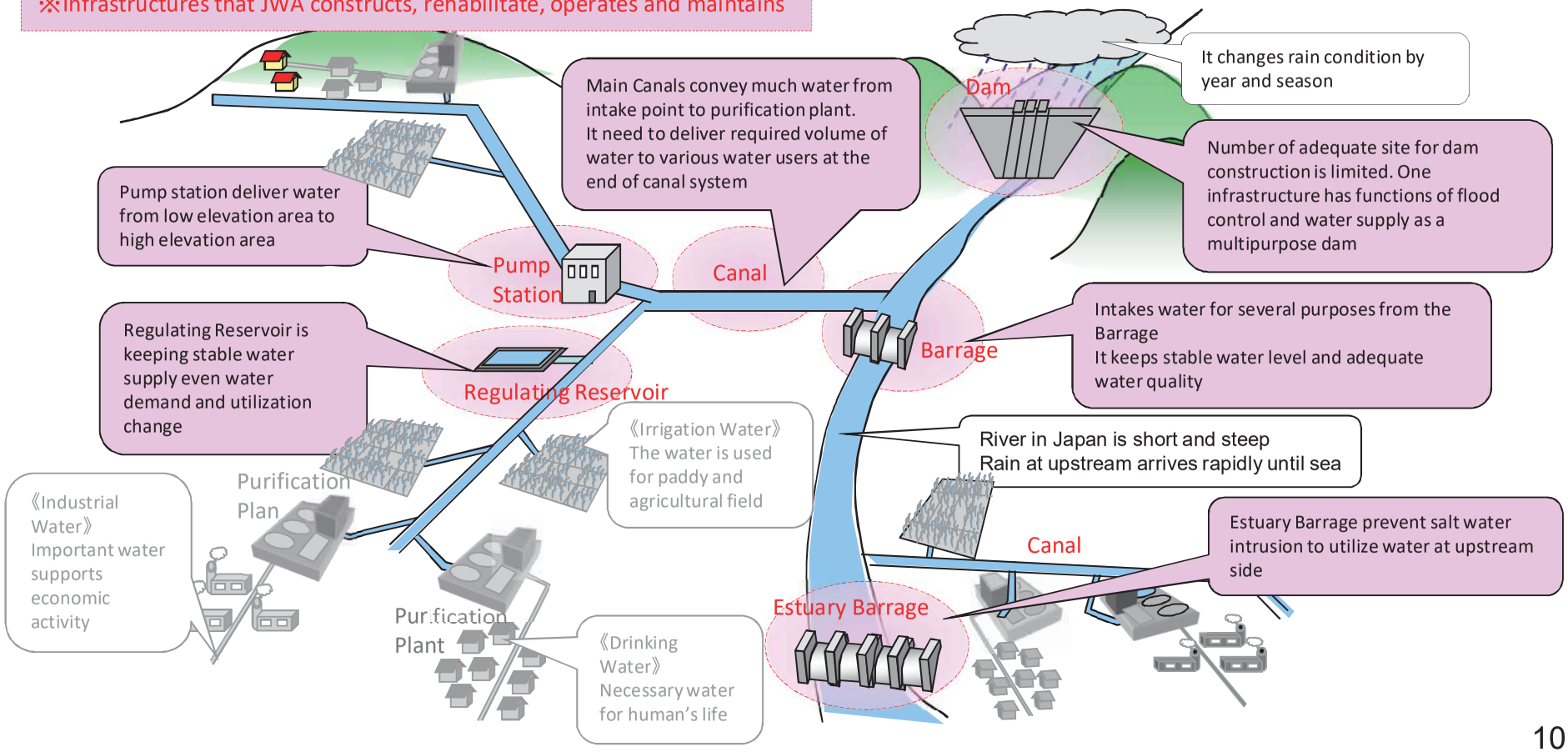
Features of Japan Water Agency

国土交通省

■JWA implements stable water supply for regions where need water due to industrial development and concentration of population (3 metropolitan areas (Tokyo, Osaka, Nagoya), Shikou and Kyusyu) through construction, rehabilitation and operation & maintenance of water resources infrastructures

■JWA implements precise operation corresponding conditions of rain and water demands changing for 24 hours and 365 days continuously approx.. 3000km canals, 17 barrages and headworks, approx. 130km lake dike and 46 dams and reservoirs

※Infrastructures that JWA constructs, rehabilitate, operates and maintains



Definitions of dam facility

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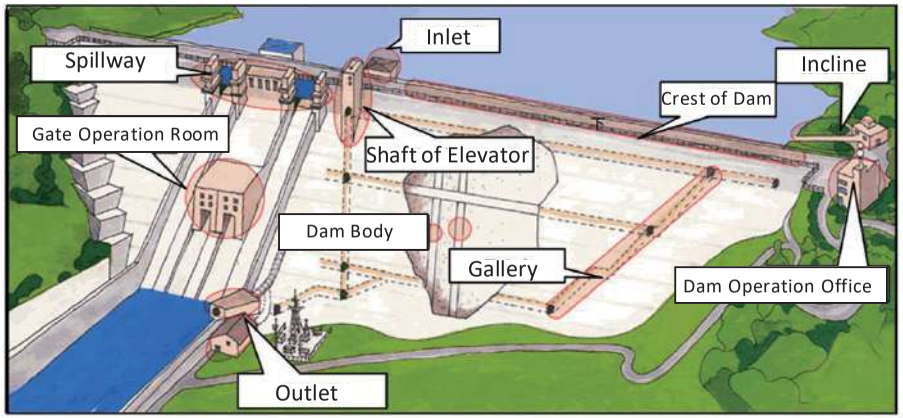
- Dam Facility
  - Civil Engineering Structures
    - Dam Body
    - Spillway
    - Foundation (Including grouting)
    - Gallery
    - Outlet (Civil Engineering Structures)
    - Slopes around Dam Body
    - Inspection Road
  - Machinery
    - Gates and Valves
    - Incline
    - Booms for Drift Wood
    - Lift
    - Drainage from Gallery
    - Water Quality Conservation Facility
  - Telecommunication Equipment
    - Power Supply System
    - Telecommunication System
    - Control System for Dam Operation (Dam Computer)
    - Electronic Equipment that is not including Dam Computer
    - Discharge Warning System
    - Micro Power Generation Plant
    - Lighting Equipment
  - Slopes around Reservoir
    - Slope Protection Structure
    - Natural Slope
  - Instrument
    - Hydrology and Hydraulics Instrument
    - Meteorological Instrument
    - Water Quality Monitoring Instrument
    - Dam Body Deformation Instrument
  - Others
    - Buildings
    - Piles of Land Boundary



Revision of River Law

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○Revision of River Law in 2013, obligation of operation & maintenance is stipulated

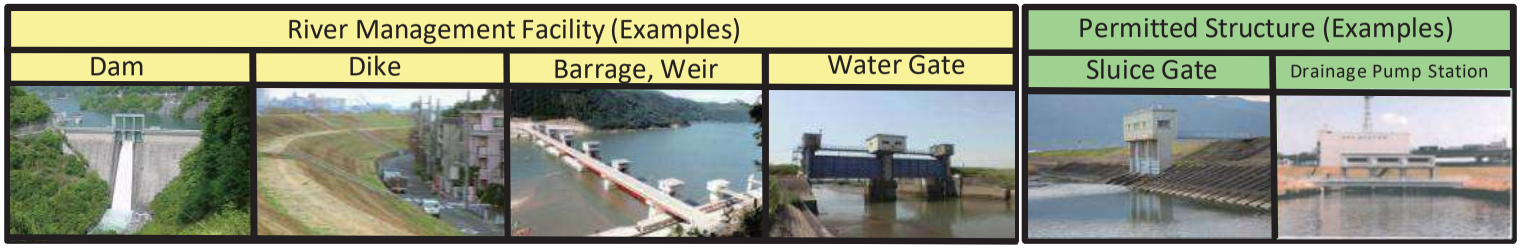
※Law on revision of a part of Flood Fighting Law and River Law（Promulgation on 12th June 2013, enforcement on 11th July and 11th Dec. 2014）

■Stipulation of obligation of Operation & Maintenance

(Term No.2, Article 15, River Law)　Enforcement on 11th Dec. 2013

・Stipulation on obligation of operation & maintenance by river regulator and operator to keep adequate condition of river management facility and permitted structures

In detail



■Technical Standard on Operation & Maintenance (Governmental /Ministerial Regulation)

Enforcement on 11th Dec. 2013

- Implementation of patrol at adequate timing to remove obstacles for keeping functions of facility with consideration on structures of river management facility
- Certain timing and method, such as visual inspection and others
- Adequate frequency inspection, such as once in one year or more for dam and dike that has important influence for keeping public security
- Implementation of adequate countermeasures, such as operation and maintenance works when we find troubles, damages and corrosions

（Inspection of dike）

（Inspection of Sluice Gates）

Regarding river management facility, it can not conduct easy and tentative responses to avoid risks, such as tentative closed of dangerous area. It is different from other social infrastructures

Maintenance works for Dam Facility

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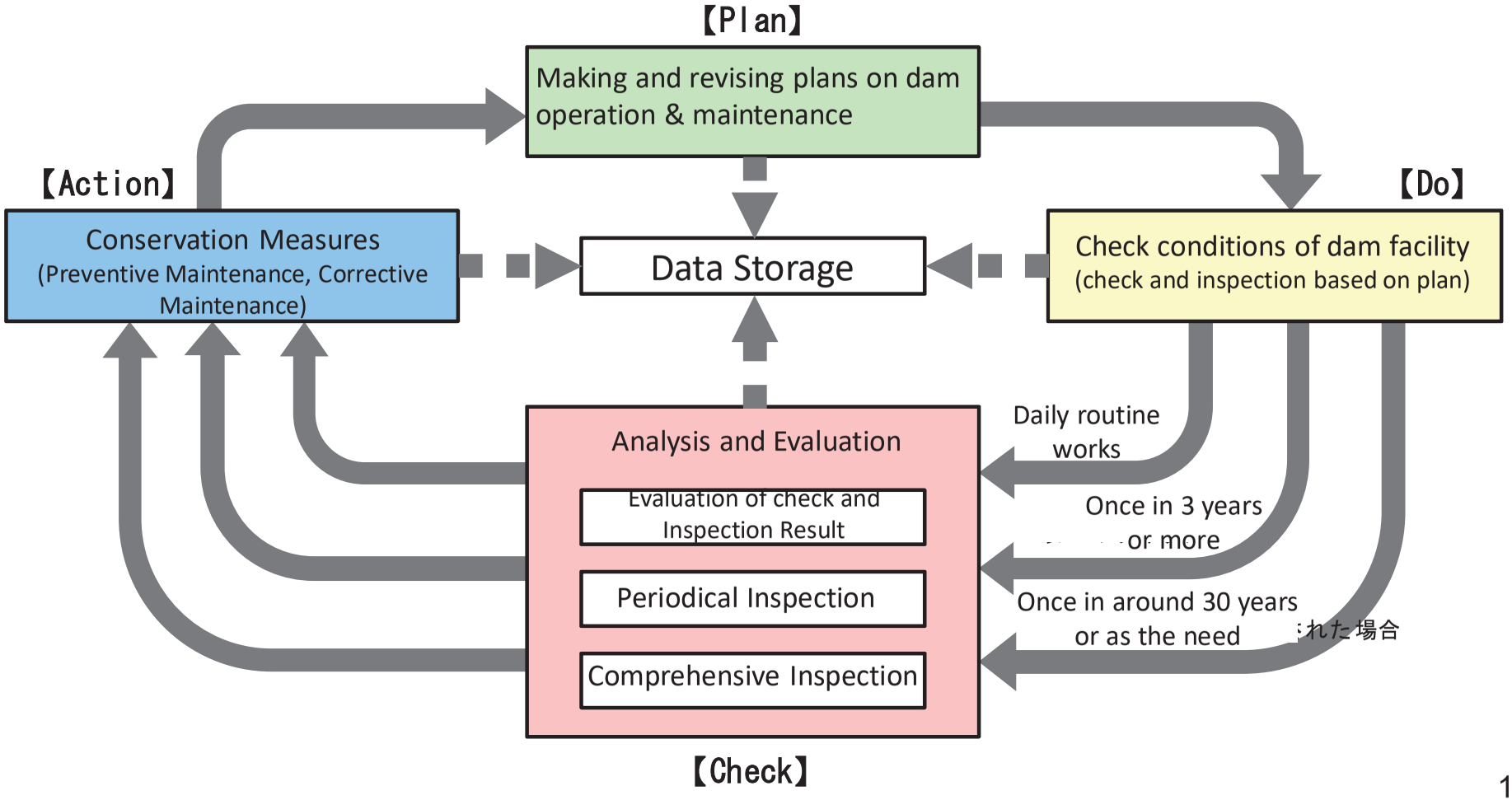
- Regarding Dam Facility, it is important to maintain with PDCA cycle that combinates daily patrol/check and Mid and Long-term check/inspection
- Data and information on maintenance works should be shared and stock and organized in systematic as soft data for effective and efficient operation & maintenance



Check and Inspection for Dam Facility O/M

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- Check and Inspection is consisted of 1) Daily patrol and check by dam operator, 2) Comprehensive Inspection that is came form view point of long term from dam experts, 3) Periodical Inspection by dam experts other than dam operators
- Patrol is implemented for general confirmation on situations of dam facilities, slopes of around reservoir, water quality, drift wood and illegal actions. It is clearly classified from Inspections

Composition of check and inspection for dam facility

- Check and Inspection for Dam Facilities
  - Patrol and Check for Dam Facilities (by Dam Operator)
    - Daily patrol and check
      - Daily patrol and check (daily, monthly, annual)
        - Patrol (General confirmation of situation)
        - Daily check (Confirmation by Visual and measuring)
      - Check for emergency (Earthquake, flood and others)
    - Comprehensive Inspection (every 30 years, based on advices from experts)
  - Check for Dam Facilities (by Expert other than Dam Operator)
    - Periodical Inspection (Once in 3 years)

Patrol (General Confirmation of Situation)

Check
(Confirmation of Situation by Visual and measuring check)

Dam O/M (Confirmation of situation)

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Patrol

Check the Dam Body

Check the Machinery

Check Telecommunication Equipment

Check the CCTV

Check discharge warning

Measuring Seepage/Leakage

Measuring Landslide

Patrol (Reservoir)

Flow Measurement

Sedimentation Survey

Sampling for Water Quality

Dam O/M (Conservation Measures)

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Renewal of Dam Computer

Gate Painting

Renewal Emergency Generator

Renewal Wire Rope for Gate

Slope Protection at Reservoir

Countermeasures for Sedimentation

Removal of Drift Wood

Water Management at Dam

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【Flood】 High Water Management

- Collecting Meteorological and Hydrological Data
- Check the discharge warning system
- Decision of discharge
- Warning and Patrol at downstream
- Notification to related agency
- Flood Control
- END
- Notification to related agency

To Low Water Management

To High Water Management

【Normal and Drought Situation】 Low Water Management

- Stable Water Supply
- Maintenance Flow
- Monitoring Flow Regime
- **Environmental Conservation**
  - Flushing
  - Increasing River Flow

Collecting Information → Forecasting → Planning, sharing Coordination → Operation

Dam Operation & Maintenance Rule

Contents of Dam O/M Rule

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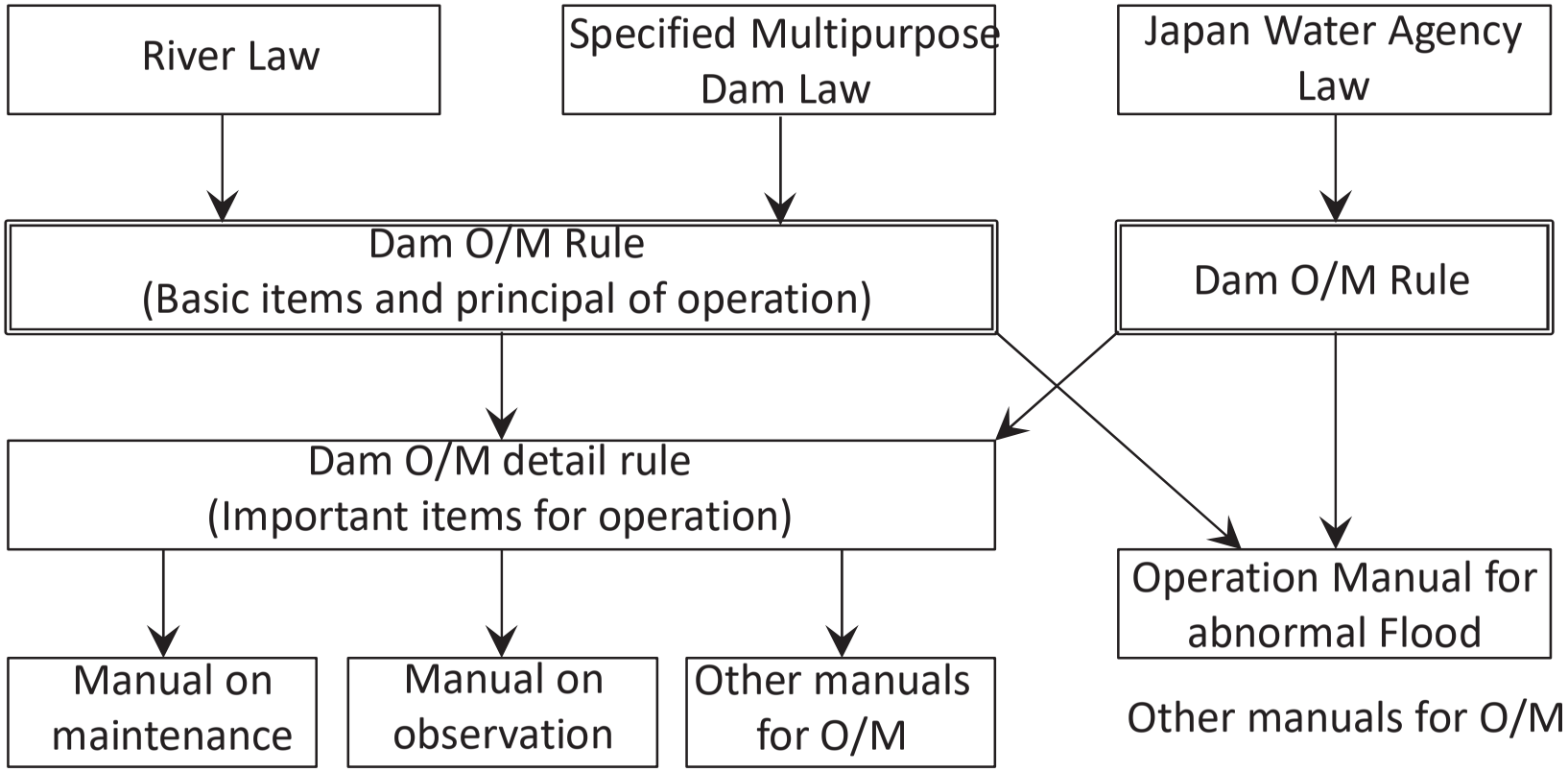
- Maximum and minimum reservoir water level, method of storage and discharge in flood season, irrigation seasons and others
- Maintenance works of dam facility for dam operation
- Observation of meteorological and hydrological data
- Necessary actions for discharge from dam
- others for necessary actions and works for dam operation



A6-3-No.004-114

Example of Dam O/M Rule (Example of Isawa Dam)

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General Specification of Isawa Dam

【Specifications】

- ●Operation started : 2014
- ●Hight of Dam Body : 127 m
- ●Purposes : Flood Control, Maintenance Flow, Irrigation, Drinking Water, Hydropower
- ●Type of Dam Body : Rock-fill
- ●Reservoir Capacity : 143 million m3
- ●Spillway : Natural Overflow type

Contents of Dam O/M Rule (Example of Isawa Dam)

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『Dam Operation & Maintenance Rule』
it concretely stipulates operation and maintenance procedures and actions for maximizing effects of dam

Table of Contends of Dam O/M Rule

Chapter 1 General Provision
- Article 1 General Notices
- Article 2 Dam Reservoir Usage

Chapter 2 Criteria of Reservoir Water Levels
- Article 3 Definition of Flood
- Article 4 Flood Season and Non-Flood Season
- Article 5 Criteria of Reservoir Water Levels
- Article 6 Normal Maximum Reservoir Water Level
- Article 7 Surcharge Reservoir Water Level
- Article 8 Reservoir Water Level for Flood Control Preparation (Flood Season Control Level)
- Article 9 Reservoir Water Level for Water Utilization

Chapter 3 Distribution Reservoir Capacity
- Article 10 Usage of Flood Control Capacity
- Article 11 Usage of Capacity for Maintenance for Normal Functions of River Water
- Article 12 Usage of Capacity for Irrigation Supply
- Article 13 Usage of Capacity for Domestic Water Supply
- Article 14 Usage of Capacity for Hydropower

Chapter 4 Flood Control
- Article 15 Organizations for Flood Response
- Article 16 Actions for Flood Response
- Article 17 Flood Control Operation
- Article 18 Draw-downs after Flood Control
- Article 19 Releasing Organization for Flood Response

Chapter 5 Water Supply
- Article 20 Cases of Possible of Discharge
- Article 21 Principles of Discharge
- Article 22 Discharge for Maintenance of Normal Function for River Water
- Article 23 Discharge for Irrigation Water Supply
- Article 24 Discharge for Domestic Water Supply
- Article 25 Decision of Discharge Volume
- Article 26 Procedure of Discharge Warning
- Article 27 Procedure of Gates Operation

Chapter 6 Inspection and Maintenance of Facility
- Article 28 Measuring, Check and Maintenance
- Article 29 Observations
- Article 30 Data Recording

Chapter 7 Others
- Article 31 Descriptions on Detail Rule

A6-3-No.004-116

操作細則の記載内容（事例紹介ダム:胆沢ダム）

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『Dam Operation & Maintenance Detail Rule』
it mentions supplemental explanations on important items that are mentioned on Dam Operation & Maintenance Rule for dam operation and flood control

Table of contents of Dam Operation & Maintenance Detail Rule

Article 1 General Notices
Article 2 Calculation Procedure of Inflow Rate
Article 3 Organization for Flood Response
Article 4 Notices to Related Agencies on Flood Response
Article 5 Releasing Organization for Flood Response
Article 6 Discharge in Special Unavoidable case
Article 7 Principals of Discharge
Article 8 Items that should be approved by Director General
Article 9 Cases of Notice and Warning on Discharge
Article 10 Area of Notice and Warning on Discharge
Article 11 Procedure of Notice and Warning on Discharge
Article 12 Contents of Notice and Warning on Discharge
Article 13 Names of Gates and Valves
Article 14 Procedure on Operation of Normal Spillway No.1 Gate
Article 15 Procedure on Operation of Normal Spillway No.2 Gate
Article 16 Procedure on Operation of Main Emergency Gate of Outlet
Article 17 Procedure on Operation of Sub Emergency Gate of Outlet
Article 18 Procedure on Operation of Main Outlet No.1 and No.2 Gates
Article 19 Procedure on Operation of Sub Outlet No.1 and No.2 Gates
Article 20 Procedure of Operation of Inlet Gates
Article 21 Procedure on Operation of Maintenance Gates
Article 22 Measuring, Check and Maintenance
Article 23 Observation
Article 24 Recording Gates Operation Data and others
Article 25 Contents of Reporting
Article 26 Annual Report
Article 27 Inspections
Article 28 Others

Flood Control by Dam

Function of Flood Control by Dam

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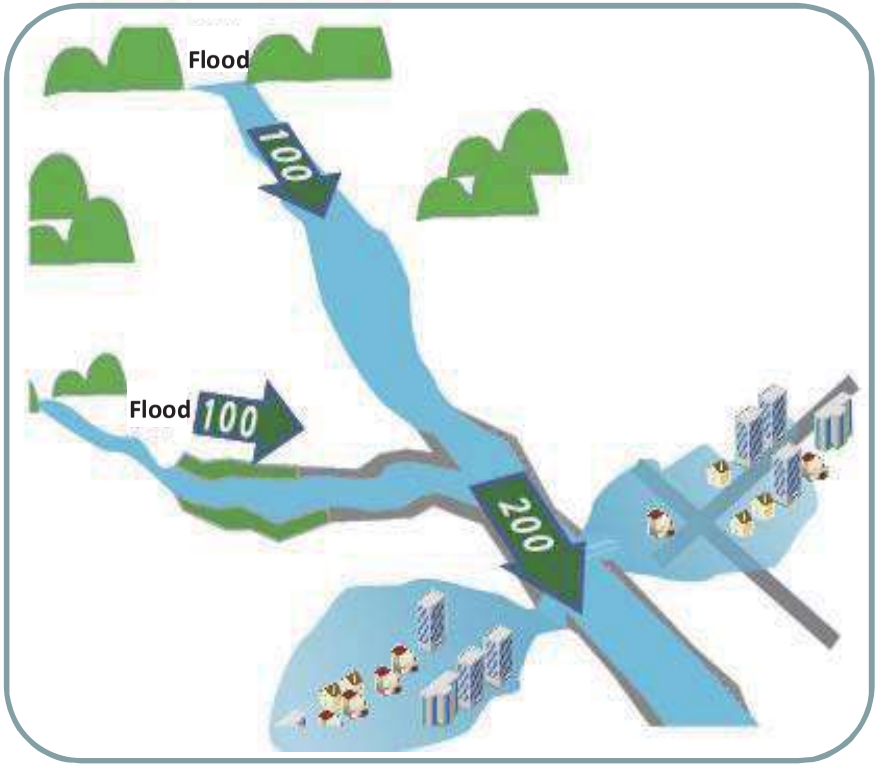
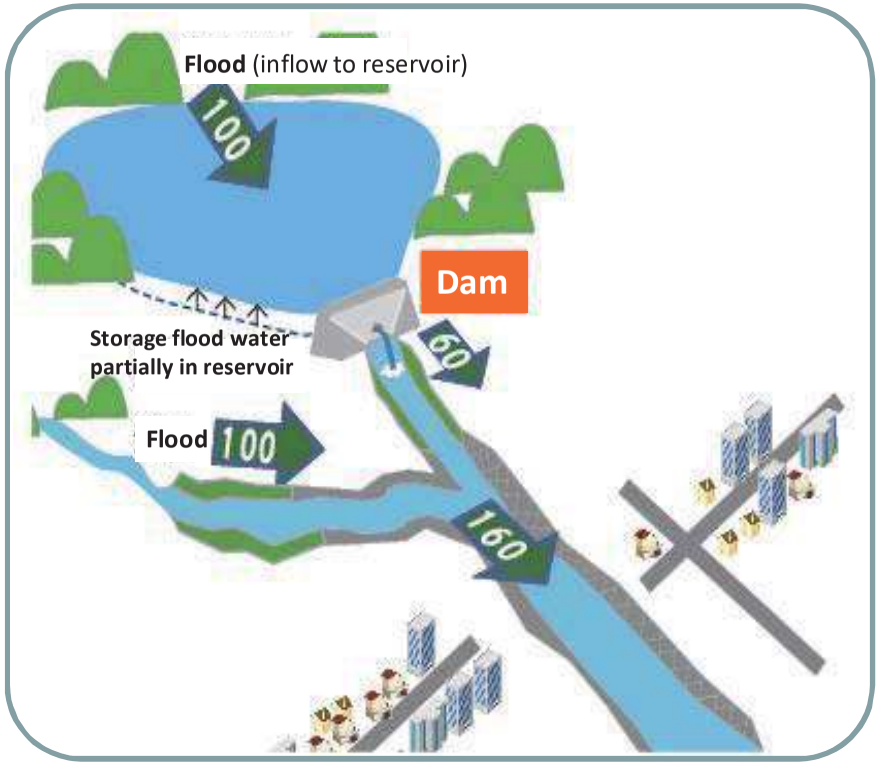
- Storage flood water into dam reservoir to reduce risk of flood in downstream
- Flood control is consisted of river and dam functions





If dam is not constructed, flood water flows directory to downstream. It makes high risk of inundation damages

Dam can storage partial volume of flood water from upstream in reservoir to reduce discharge volume to downstream. It reduces risk of inundation from overflow of river in downstream.

Flood Control by Dam (Hydrograph)

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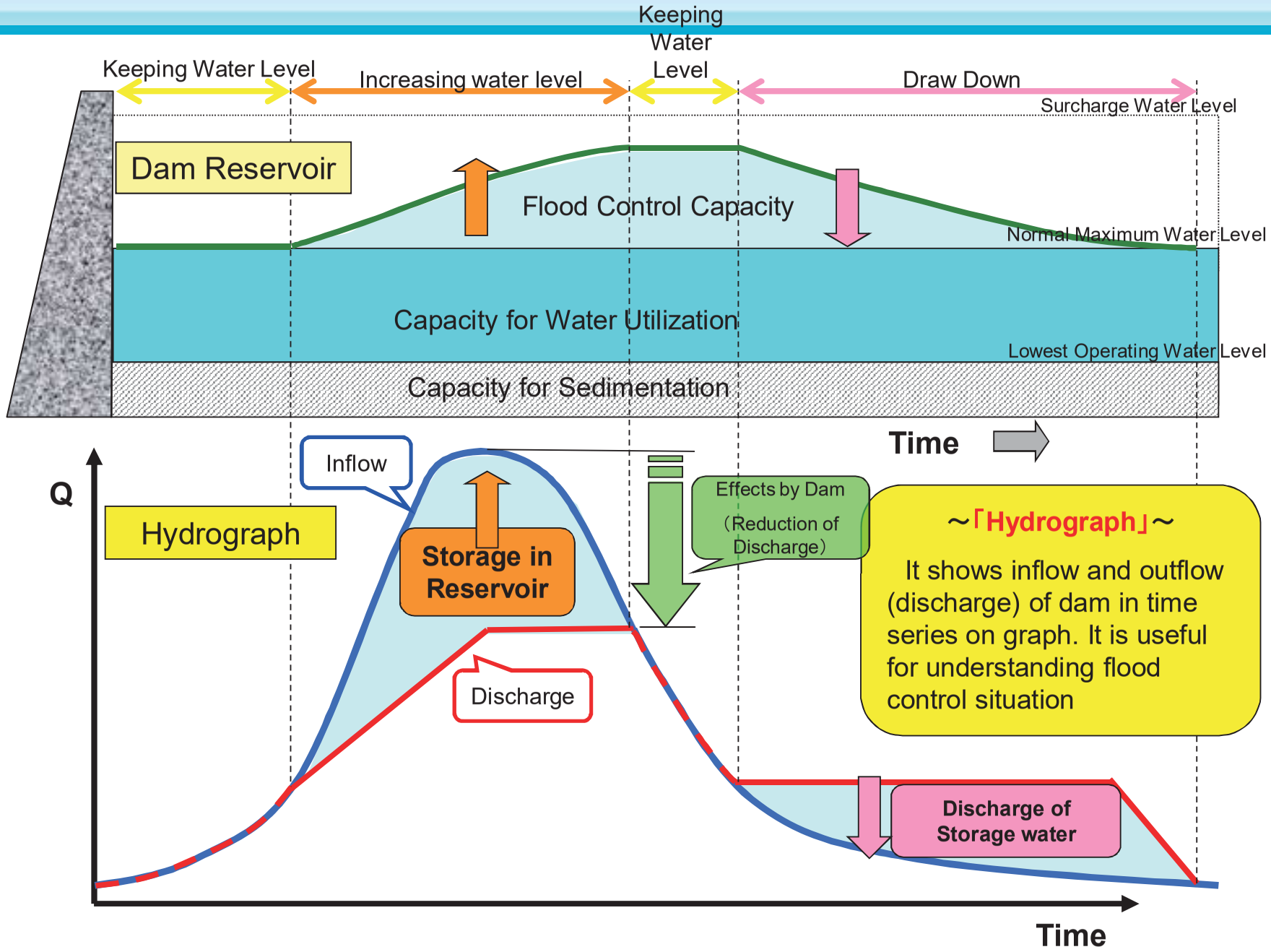

~「Hydrograph」~

It shows inflow and outflow (discharge) of dam in time series on graph. It is useful for understanding flood control situation

Method of Flood Control by Dam

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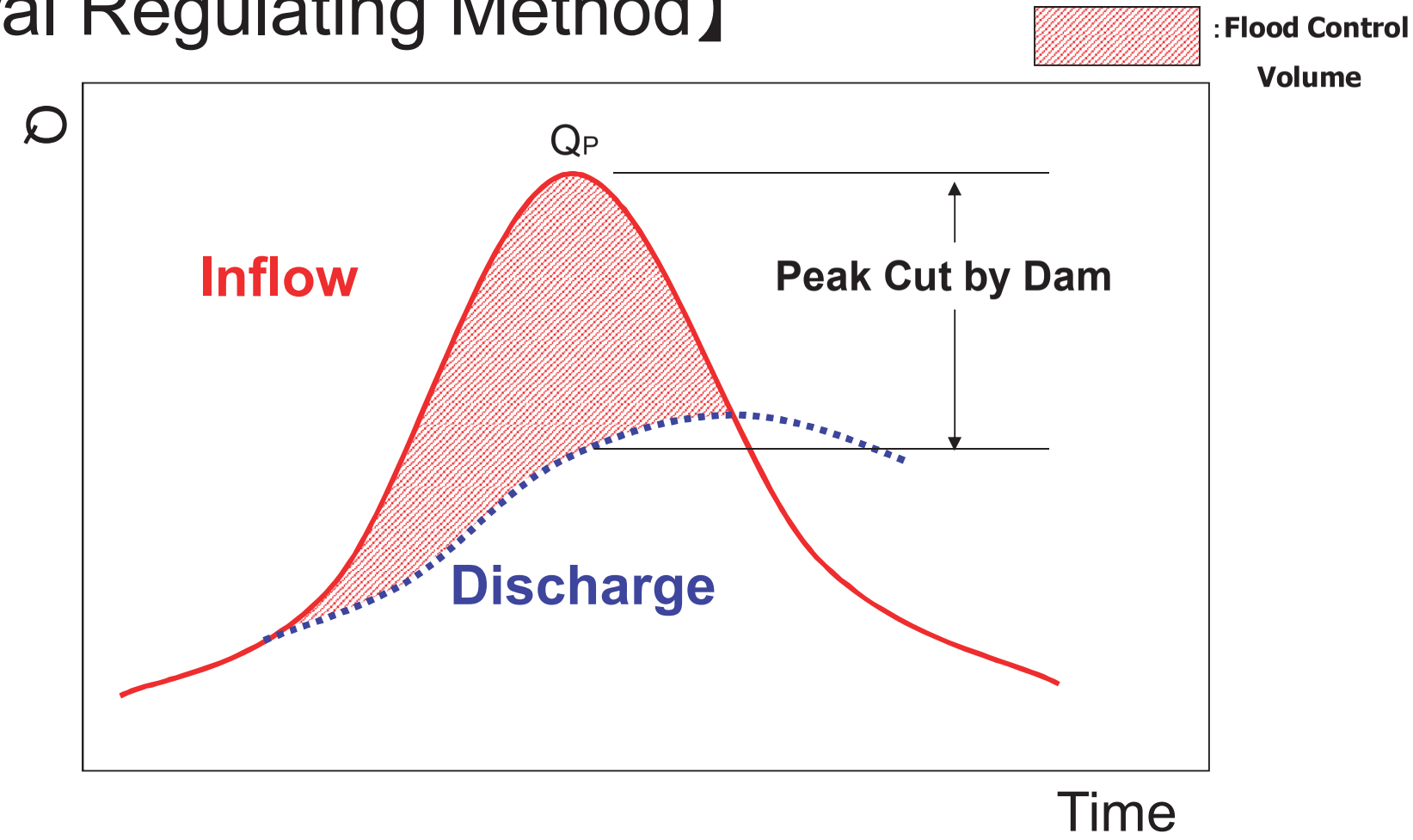
【Natural Regulating Method】



●This method is case of no gate type or keeping gates same open degree without any gate operation for flood control. The method can effect for dam that has small catchment area and rapid run-off from catchment area, because it does not need manual operation. Moreover, it is one of easy operation for flood control

Method of Flood Control by Dam

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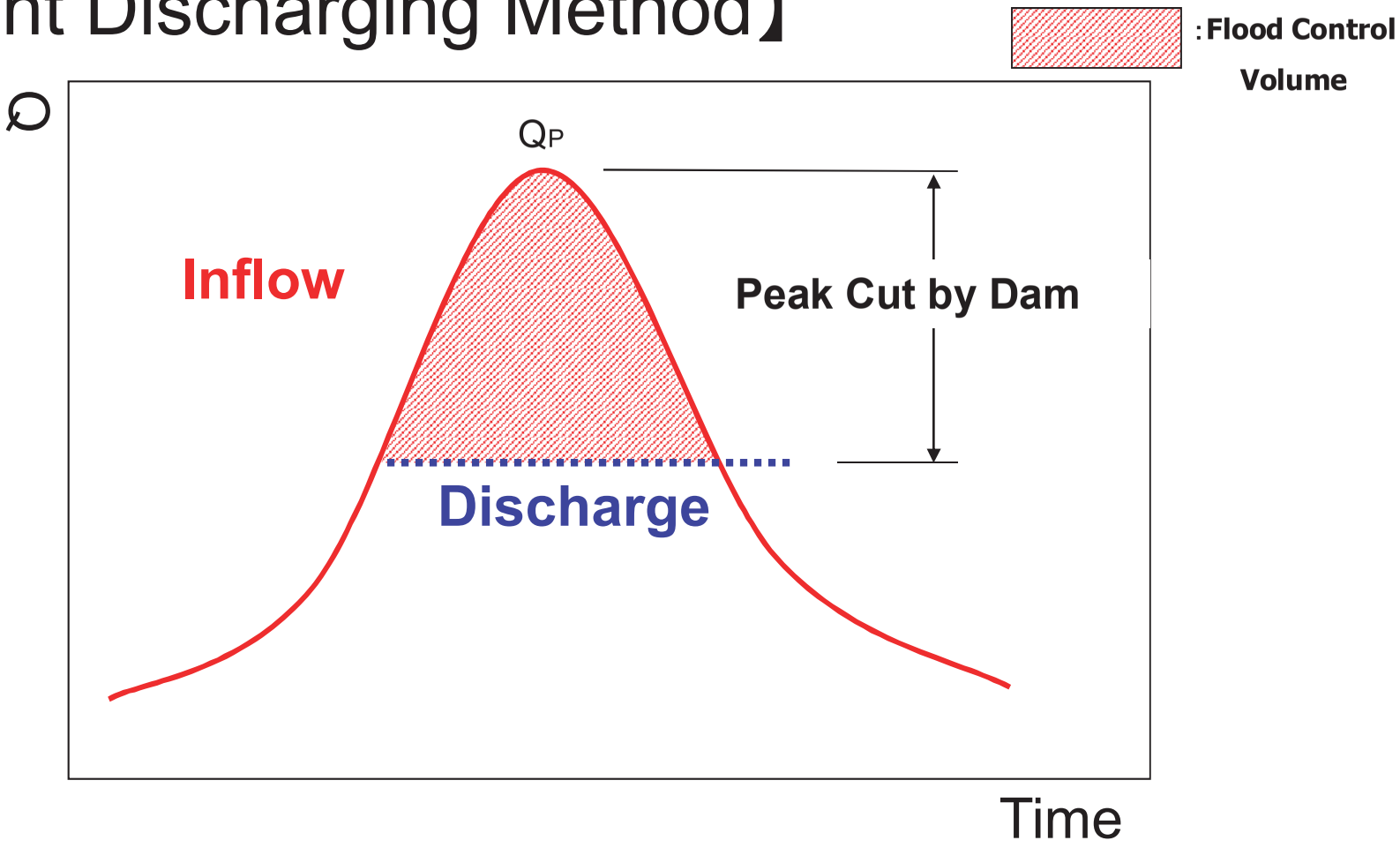
【Constant Discharging Method】

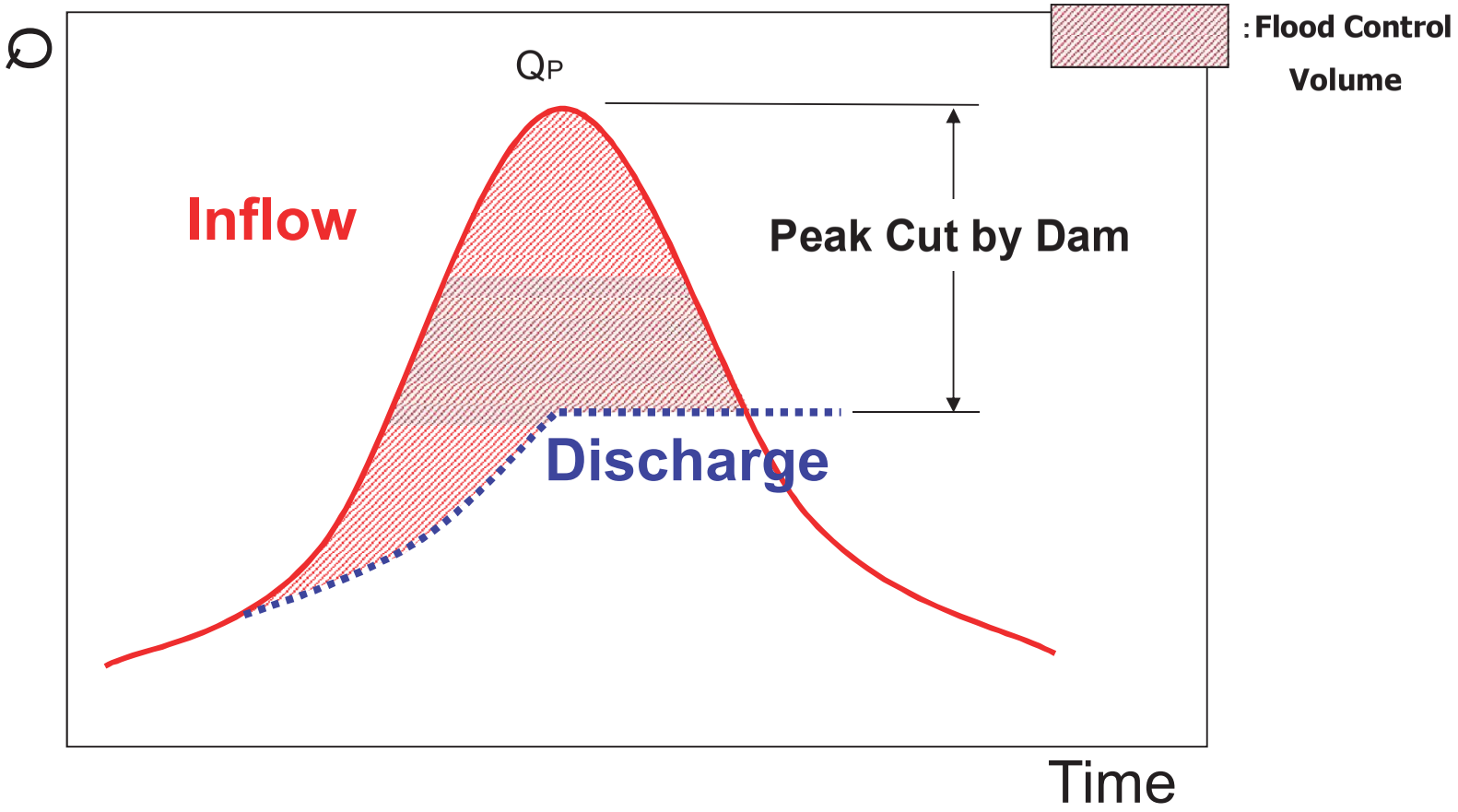


●The method is that peak cut by keeping constant (same volume) discharge. The method can effect the flood control for river where river normalization has been implemented, However, effect of the method is relatively small for small-middle scale rivers

Method of Flood Control by Dam

国土交通省

【Constant Rate and Constant Discharging Method】



●After started flood control, discharge is increased with constant rate until inflow reaches at peak. After inflow reaches at peak, discharge is kept constant (same volume). The method can be expected high effect of flood control for small-middle scale rivers.
Moreover, the method is adequate for river where river normalization has not been progressed.

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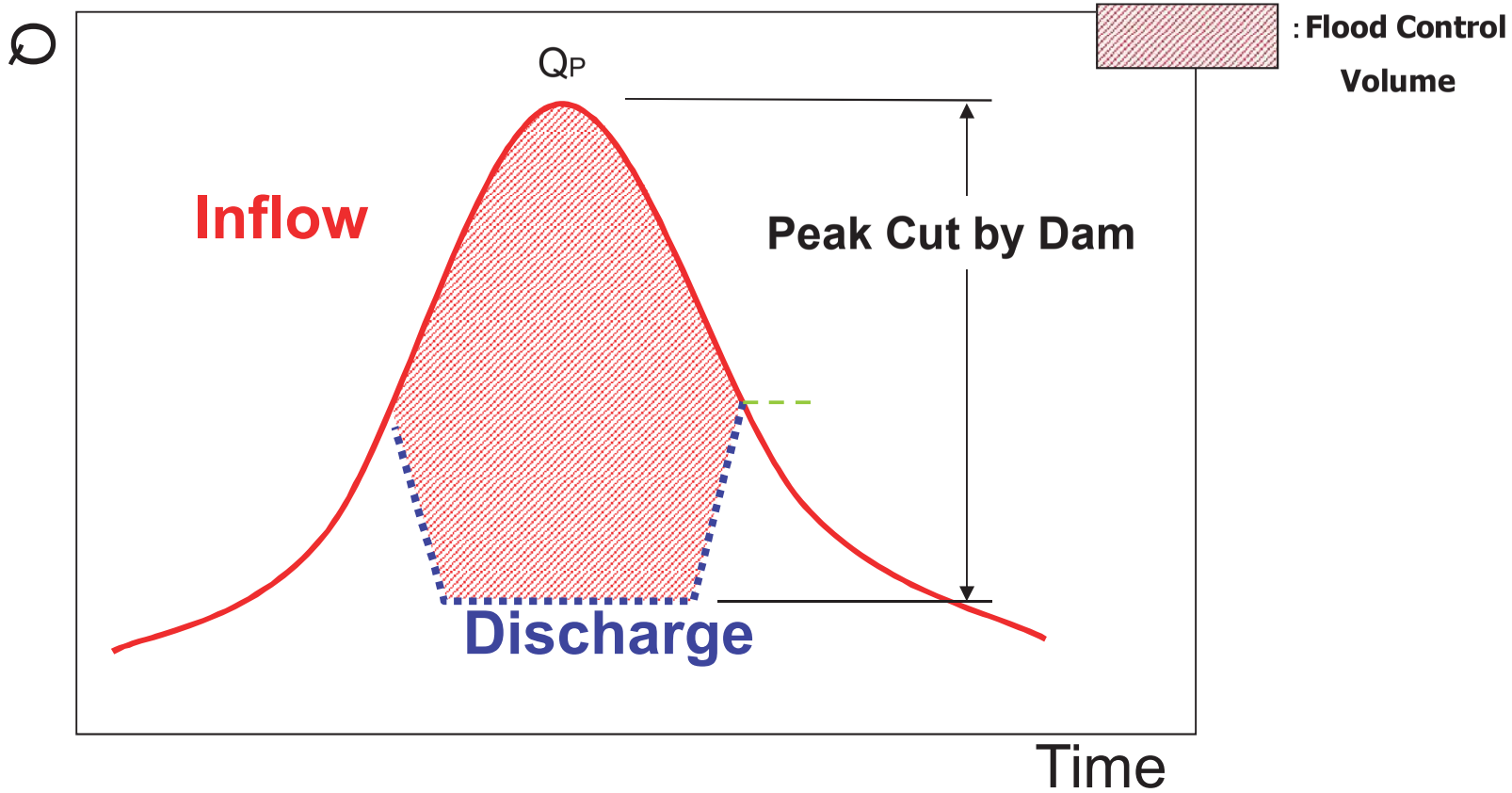
【Adaptive Release-Rate Method（Pan Bottom Control Method）】



●This is effective method for maximizing peak cut during inflow is high with considering flood situation in downstream
However, the method is not applicable for dam that has small catchment area and rapid run-off from catchment area, because high accuracy flood run-off forecasting is indispensable

Response for Earthquake

A6-3-No.004-125

Emergency Inspection after Earthquake

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●We have regulated 1) Earthquake scale that dam operators have to report on inspection result, 2) Items that dam operators have to inspect. Because it is necessary for dam operators to inspect situation of damages on dam body and it footing, slopes, spillway and outlet facility, telecommunication equipment and others, if earthquake happens near dam

1. Earthquake scale that dam operators need to make the report

○Maximum Seismic Acceleration that is observed by a seismometer at dam foundation or dam body bottomの is 25 gal or more

○Seismic Intensity Scale that is observed by meteorological station near dam site is 4 or more

2. Items of Inspection

○Inspection is consisted of 2 steps

1st Inspection: Visual Inspection for dam body and its footing, slopes, spillway and outlet facility, Telecommunication equipment and others

2nd Inspection: Detail inspection of appearance and measuring of facilities that were inspected by 1st inspection

3. Contents of report

○Contents of reports are regulated by past time from earthquake happens. There are formatted sheet

①One (1) hour or less after earthquake happens

Date and time of earthquake happens, Maximum Seismic Acceleration and Seismic Intensity Scale, Name of dam that have to be inspected

②Three (3) hours ore less after earthquake happens

Result of 1st inspection, necessity of 2nd inspection and schedule if 2nd inspection is necessary

③Twenty-Four (24) hours or less after earthquake happens

Result of 2nd Inspection

A6-3-No.004-126

Example of Damages at Concrete Dam

国土交通省

Break-away of Concrete Handrail at Dam Crest

Situation of downstream side of dam body (No Damage)

A6-3-No.004-127

Example of Damages at Fill Type Dam

国土交通省

Cracks that runs at up and downstream direction

Situation of dam crest (No damage)

Crack at foundation of handrail of dam crest
(it does not reach at pavement)

[Reference] Iwate-Miyagi Earthquake in 2008

A6-3-No.004-128

Issues on Dam O/M

① Latest Technical Standard

② Dam Renewal Vision

③ Countermeasures for Sedimentation

④ Promoting installment of Micro-Hydropower

⑤ Applying new technology for O/M

①Latest Standards for O/M

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Standards that are formulated in several years for O/M	Date
Manual on Dam Comprehensive Inspection	Oct. 2013
Technical Criteria on River Works, Chapter of O/M [Dam part]	April 2014
Manual of water quality monitoring at dam reservoir	March 2015
Guideline on middle-scale flushing discharge（Draft）	May 2015
Guideline on Periodical Inspection of Dam	March 2016
Dam Renewal Vision	June 2017
Manual and Descriptions on checking Dam Operation Rules to improve flood control method to maximize dam functions and effects	July 2017
Guideline on sediment management at dam reservoir (Draft)	March 2018
Guideline on countermeasure for drift wood at dam reservoir (Draft)	March 2018
Guideline on water quality improvement at dam reservoir (Draft)	March 2018
Manual on robot for facility maintenance in the water (Tentative)	April 2018 (Tentative)

Dam O/M part of Technical Criteria on River Works

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- Technical Criteria on River Works has been consisted of Chapters on Survey, Planning, Design and O/M [River]
- Chapter on O/M [Dam] was made for keeping and improving technical quality on dam O/M in April 2014. It systemizes accumulated technique and knowledge on dam O/M to transfer it next generation human resources development

Systemizing technical standard on Dam O/M

■Compile accumulated technical standard on Dam O/M systematically

■Make clear about indications on standard
Classified in five (5) category as "Approach", "Mandatory", "Standard", "Recommendation" and "Example"

■Systematic organizing on many decrees on dam O/M, many manuals that are made and classified by dam type and O/M method

■It will be updated properly with new technology development by future researches

Contents of Dam O/M Part, the Technical Criteria

Charter 1 Outline
1. Purpose
2. Basic Policy
3. Scope of Application

Chapter 2 Operation & Maintenance of Dam Facility and Reservoir
1. Systematic O/M of Dam Facility and Reservoir (Standard on dam maintenance, Plan on Long-Life of Dam Facility, Maintenance of Reservoir)
2. Check and confirmation on situation of dam facility and reservoir (Check, Observation, Survey, Recording and others)
3. Evaluation and countermeasures of dam facility maintenance (Civil Engineering Structures, Machinery, Telecommunication Equipment, Hydropower Station for Dam O/M, Slope around Reservoir, Measuring and Observation Instrument, Data Recording)
4. Countermeasures for Reservoir Maintenance (Sedimentation, Water Quality Conservation, Drift Wood, Illegal Actions, Proper Utilization Revitalization of Upstream Area, Environment Conservation, Water Quality Problem)
5. Permitted Structures

Chapter 3 Hydrology Management
1. General Items (Operation & Maintenance Rules, Observation of Hydrological and Hydraulics Data and Collecting Meteorological Data)
2. Management of Operation (Operation of Dam, Flexible Dam Operation)
3. Drought Management
4. Recording Operation & Maintenance Data
5. Sharing Information and Data on Dam Operation & Maintenance

Chapter 4 Follow Up Dam Operation & Maintenance

A6-3-No.004-131

Dam Comprehensive Inspection

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- Regarding on dam maintenance, dam operators have conducted routine maintenance (daily patrol and check, emergency inspection). Moreover, periodical inspection has been conducted by dam experts every 3 years
- Dam body and others, civil engineering structures, can be expected long-life*, if adequate inspection and necessary maintenance are implemented

  ※For examples, Nubohiki-Gohonmatsu Dam that was constructed as 1st concrete dam in Japan (completed in 1900) is still functioned for 110 years
- it enables for dam to keep safety and functions and to implement effective and efficient operation & maintenance, if degradations and damages of facilities are confirmed in advance and necessary maintenance is implemented in appropriate time
- System of "Dam Comprehensive Inspection" is launched as new measures. In the inspections, directions of long-term operation & maintenance is made by consideration of dam body and other facilities safety evaluation that focuses on aged deterioration and conditions on inside of structures from long-term point of view. Its result is reflected to operation & maintenance works (especially routine maintenance)

- ☐ Implementing Dam Comprehensive Inspection based on "Manual on Dam Comprehensive Inspection" formulated in 1st Oct. 2013
- ☐ The Manual is applied dams that are constructed as River Management Facility"
- ☐ Frequency of Dam Comprehensive Inspection is basically; 1st time have to conduct until 30 years after start O/M. After 1st inspection, frequency is once in 30 years.

Dam Completion

(by Dam Operator)

Routine Maintenance(Daily – annual)

○Based on maintenance standard of each dam (O/M Rule of each dam based on River Law)

※Other of mentioned above, periodical inspection by dam experts is implemented

Dam Comprehensive Inspection
(approx. Every 30 years)

-Organizing Records of Maintenance in Past
-Detail Survey if necessary (coring and others)
-Opinions and advices from Experts
-Evaluation of safety
-Making the Directions of O/M

・Conducting 1st time in 30 years after start O/M
・After 1st one, frequency is once in 30 years

Routine Maintenance considered on result of the Dam Comprehensive Inspection

○Implementation of conservation considered evaluation of safety and direction of O/M
○Updating prioritized maintenance points and maintenance method, if necessary

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Guideline on Periodical Inspection of Dam

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- It enables adequate dam O/M by check, analysis and evaluation of dam facility condition through "routine maintenance (daily patrol and check)","Periodical Inspection" and "Dam Comprehensive Inspection"
- "Guideline on Periodical Inspection of Dam" is updated as new version and created "Dam part, "Technical Criteria on River Works" . It is one of the actions on establishment of technical standard on dam O/M

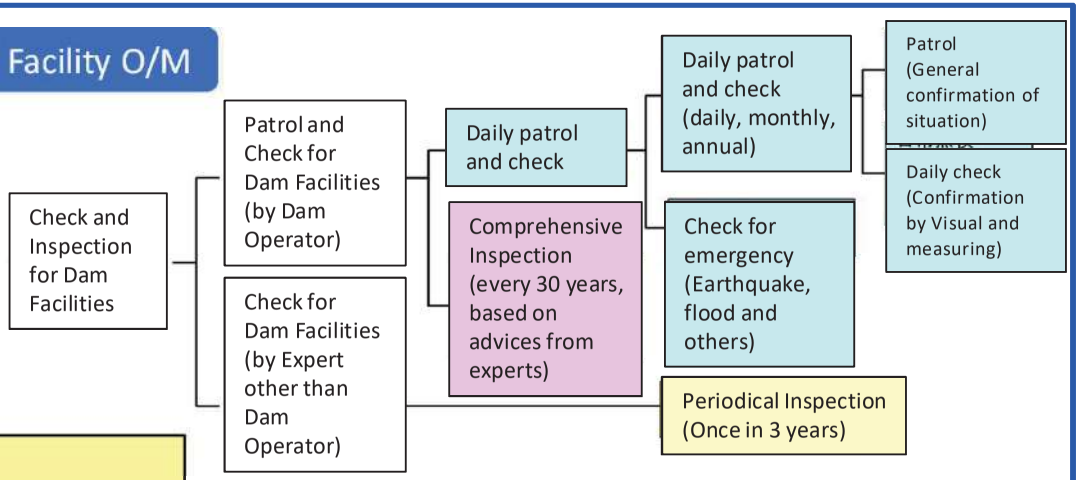
■Define of obligation of Operation & Maintenance (Term No.2m Article 15, River Law, enforced in 11th Dec. 2013)

■Composition of Check and Inspection for Dam Facility O/M

Daily Patrol and check as a Routine Maintenance
Standard:
"General Technical Standard for formulation of standard dam maintenance work"(April 2014)

Dam Comprehensive Inspection
Standard:
"Manual on Dam Comprehensive Inspection" (Oct. 2013)

Periodical Inspection
◆Standards: (March, 2016)
○"Guideline on Periodical Inspection of Dam" established in 2002 is updated and revised as "Chapter on Dam, Standard on O/M for Permitted River Management Structure"
－Major Revision Points－
- Matching with Items of Evaluation of "Dam Comprehensive Inspection"
- Clear Classification of Criterions by improvement of records
○Establishment of "Guideline on Periodical Inspection of Dam" and "Dam Chapter, standard of River Management Facility"



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Utilization of Robot for Facility Maintenance in the Water

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●In a concern on labor shortage by declining birth rate and aging population, utilization of Robot for facility maintenance in the water should be promoted for more effective and efficient maintenance at dam. Maintenance works will be tough because facility deterioration is progressed

Utilization of Robot for Facility Maintenance in the Water

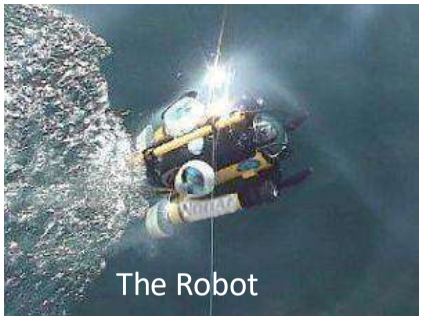
○Currently maintenance works in the water should be done by divers in case of some trouble of the facility. However, periodical checking the situation of facility in the water enables prevention of troubles in advance

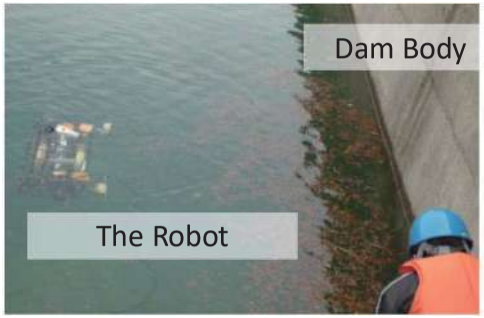
○It can be reduce maintenance cost by avoidance of serious damages

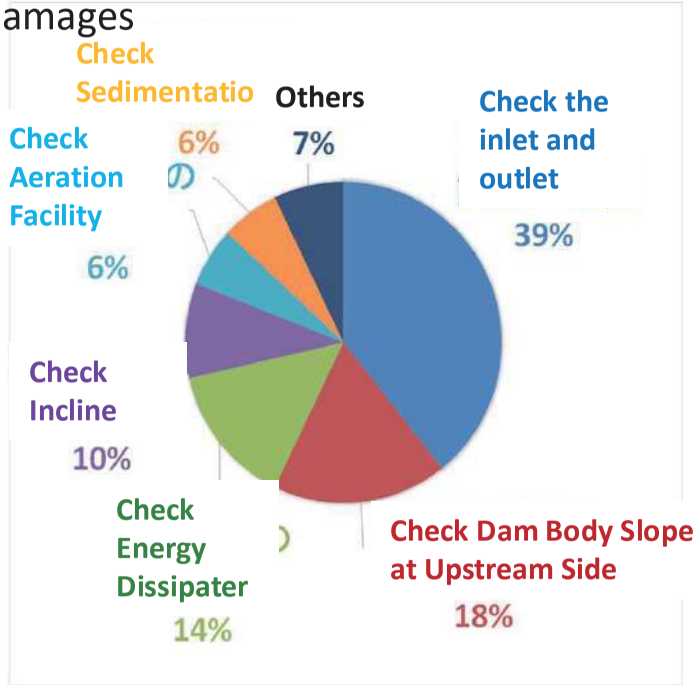
◆Example of Utilizations

(Needs from the sites)

※Hearing from dam office of MLIT and JWA (2015)







◆The Robot will be installed from 2018, consideration of evaluation result at the sites (2014 – 2015) and needs from the sites

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②Outline of Dam Renewal Vision

国土交通省

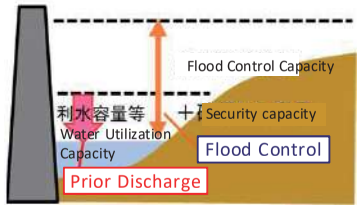
- It is important to maximizing functions of existing dam with control of total cost in a situation of severe finance limitation
- Dam Constructions had been implemented for flood control and water supply with consideration of characteristic of rivers until now. It is essential to utilize existing dams effectively and sustainable for long-term
- Examples and experiences on effective utilization of existing dams have been accumulated. Various technologies are developed for effective utilization of existing dams
- Currently flood and drought occur every year in somewhere in Japan. High frequency and large scale of flood and drought is concerned by influence from climate change

⇒ "Dam Renewal Vision" for effective utilization of existing dams has been promoted with structural and non-structural measures that are considered river characteristic and issues for 1)Long-life of existing dam, 2) Effective and advanced maintenance of dam functions, 3) Protection and improvement of functions of flood control, drought and environment and 4) Contribution for regional development

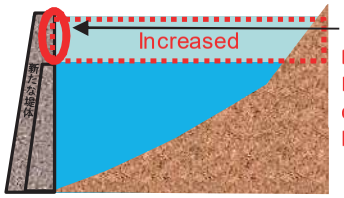
◆Examples on effective utilization by flexible operation and improvement of facility are accumulated

＜Example of flexible operation＞

・Prior discharge to reduce water level for security more capacity for flood control
・**13 dam implement as of March 2016)**



＜Example of facility improvement＞



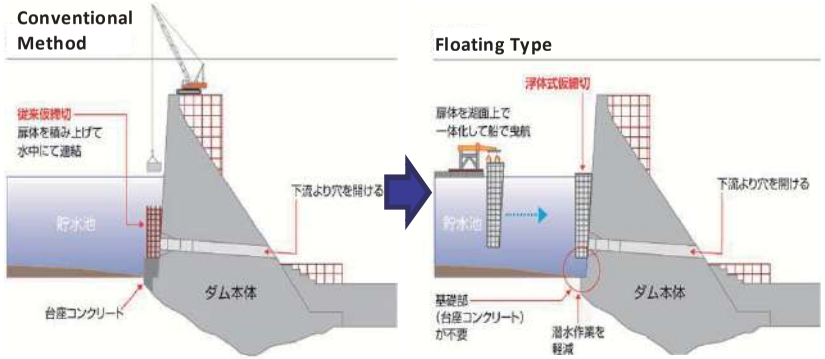
[Heightening of Dam]
Increasing reservoir capacity by dam heightening

※Ikusyunbetsu River Development Project

◆ Various technologies are developed, such as under water structural engineering work to construct in deep reservoir, high performance radar rain sensor

＜New technology at Tsuruta Dam Rehabilitation Project (Floating type coffering)＞

Steel coffering is floated and installed at once without base. It can be make dry space for construction without any disturbing operation



Formulation of "Dam Renewal Vision"(27th June 2017)

〇Formulated "Dam Renewal Vision" describes a plan for promotion of dam renewal actions on existing dam effective utilization

〇Established a committee on Dam Renewal Vision from experts and professors（Chairperson: Prof. Sumi, Kyoto Uni.)

※established on 25th Jan, 2017, open meetings were held 3 time until May 2017. The committee conducted opinion hearing from related agencies

②Outline of Dam Renewal Vision

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Plan for acceleration of Dam Renewal

It needs to accelerate implementation of countermeasures until now. Moreover, development and acceleration of Dam Renewal should be developed and accelerated with consideration of issues on Dam Renewal

1. Long-Life of Dams

- Countermeasures for current condition of Sedimentation and utilization of new technology
- Consideration of reservoir capacity allocation from dam under construction to existing dam
- Revision of Long-Life Plan, intentional conservation measures for machinery

2. Effective and Advanced O/M

- Standardization of necessary facility for advanced O/M at design stage
- Effective and advanced construction system for effective and efficient utilization of information at construction stage to O/M stage through promotion of "i-Construction"
- Maintenance by Robot for maintenance in the water, Drone and Camera
- Application of Remote Control for adequate operation in emergency case

3. Flexible and Credible Operation for maximizing facility function

- Development and research on improvement of forecasting accuracy on inflow to reservoir
- Inspection on revising operation rule to use flood control capacity for water supply
- Consideration on operation rule for effective and efficient integrated operation among several dams

4. Facility Improvement for High Functionality

- Start survey on facility improvement to promote Dam Renewal
- Concentration of river channel improvement where is lack of flow capacity to enable full function of flood control
- Integral implementation of Dam Renewal and river channel improvement, such as reinforcement of discharge capacity
- Establishment of deputizing system to enable implementation of prefecture's project by Central Government
- Formulation of "Dam Upgrade Guideline", revisions of various standards
- Opinions exchange with agencies from early stage for facility improvement project
- Consideration of reservoir capacity allocation from dam under construction to existing dam in river basin where there are several dams to promote Re-organization and Linking Dams
- Research of evaluation on investment effectiveness through salvage value and long-life of existing facility
- Visualizing Dam O/M, Risk Communications

5. Adaptation for Climate Change

- Inspections to establish rules on prior discharge and special flood control operation
- Consideration on compensation to water users for the case that water utilization capacity that released by prior discharge can not recovered
- Study on improvement of flood control, such as installment of gates at gateless dam
- Research on flexible structure that enable upgrade project easily for the future
- Examine on countermeasure against drought that exceeds planned scale
- Study on adaptation method for long-term changes, such as pattern of flood control

6. Aggressive Installment of Hydropower

- Inspection for method of function improvement for both, flood control and hydropower and for establishment of rules on utilization some flood control capacity to hydropower
- Establish "Opinion Exchange between River Regulator and Hydropower Operators
- Promotion of Private Hydropower and Public Recruitment Type Micro-Hydropower, support project formulation

7. Conservation and Renewal of River Environment

- Regarding on plan for river environment improvement, survey and research on effect evaluation and method of river environment improvement
- Formulation of system for promotion on integrated sediment management

8. Regional Development with Dam

- Consideration for improvement on existing system, promotion on actions for activation of water resources region
- Consideration on mechanism that hydropower contributes regional development

9. Overseas Expansion on Dam Renewal Technology

- Overseas expansion on dam renewal technology, such as dam restructuring and sediment countermeasures
- Study on promotion mechanism for utilization of existing organization

10. Development and Application of Technology for Dam Renewal

- Development and application of advanced technology
- Applying latest technology on the other fields
- Consideration on human resource development, transfer the technology and cooperation with University

②Outline of Dam Renewal Vision

(5) Adaptation for Climate Change

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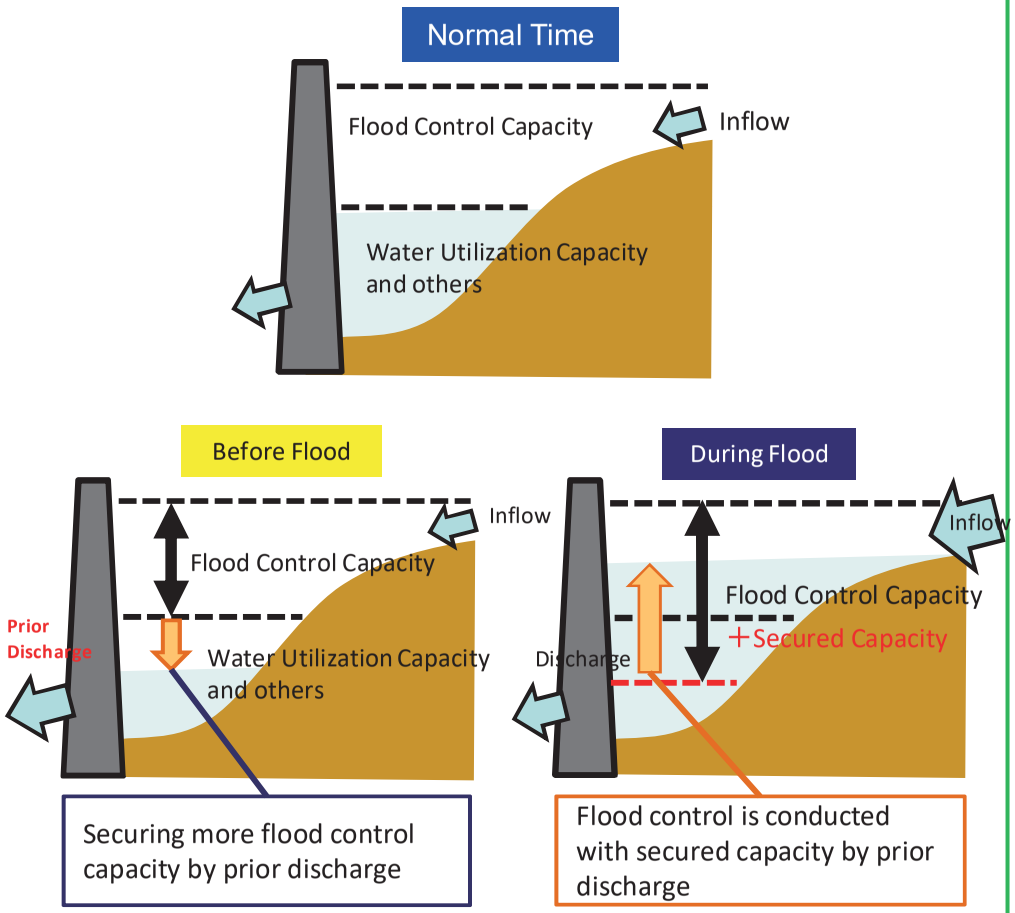
Prior Discharge

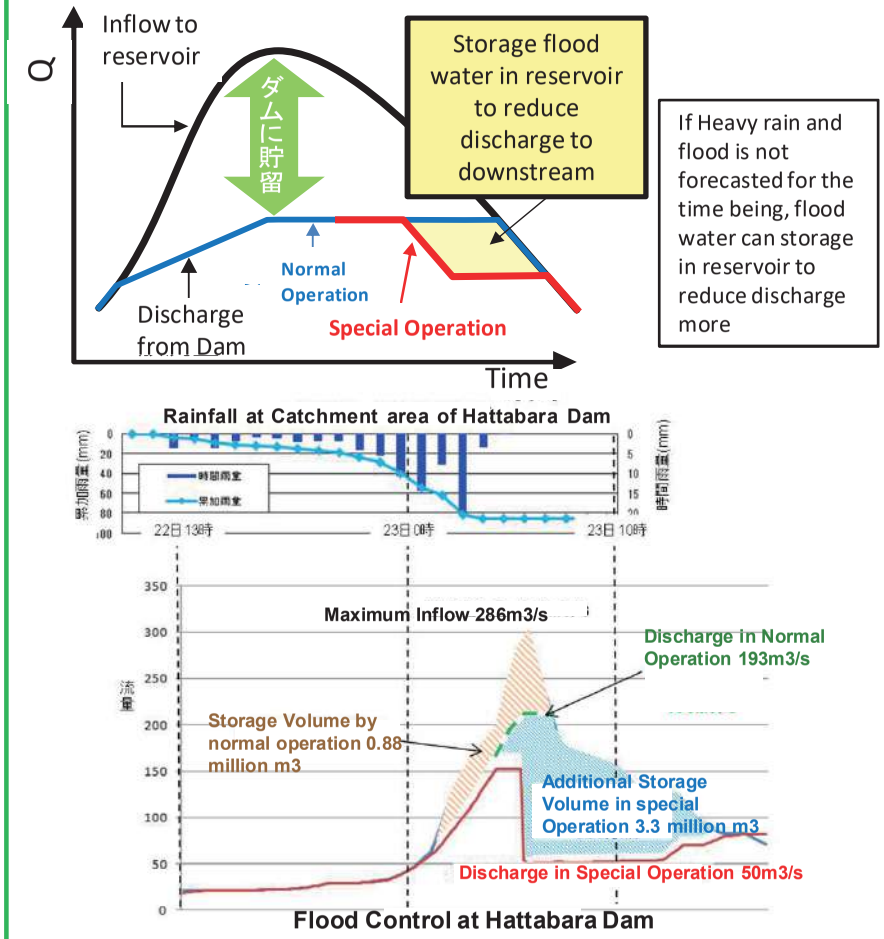
（under cooperation of water users, a part of water utilization capacity is released to use as flood control capacity before flood occurs）



※It has been implemented at 13 Dams with Procedure (as of March 2017)

Special Flood Control Operation

（Reducing discharge in during flood control based on request from river regulator or local government at downstream）



※it has been implemented at 8 dam with Procedure (as of March 2017)

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Conservation of River Environment by Flexible Operation

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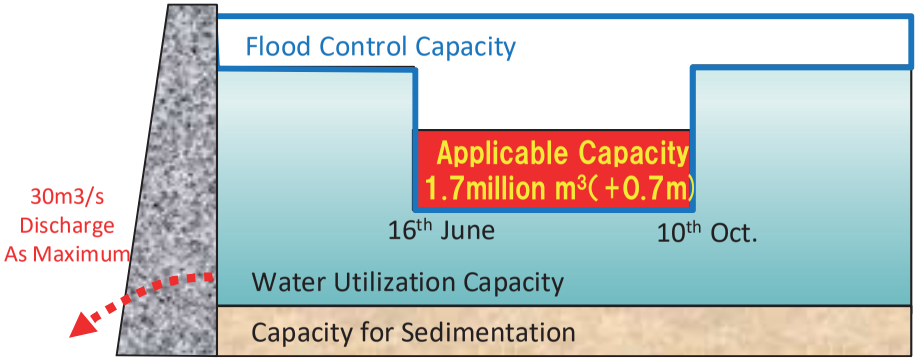
(Example in Sagae Dam)

●At Sagae Dam, the Flexible Operation (Flushing Discharge) has been conducted since 1997, for separation and replacement of attached algae, flushing sludge and slack water. The operation has been shifted as official operation since 2008. Flushing Discharge has been conducted one a week in the season (16th June to 10th Oct.) since 2008. It is confirmed that separation of attached algae and others as effectiveness

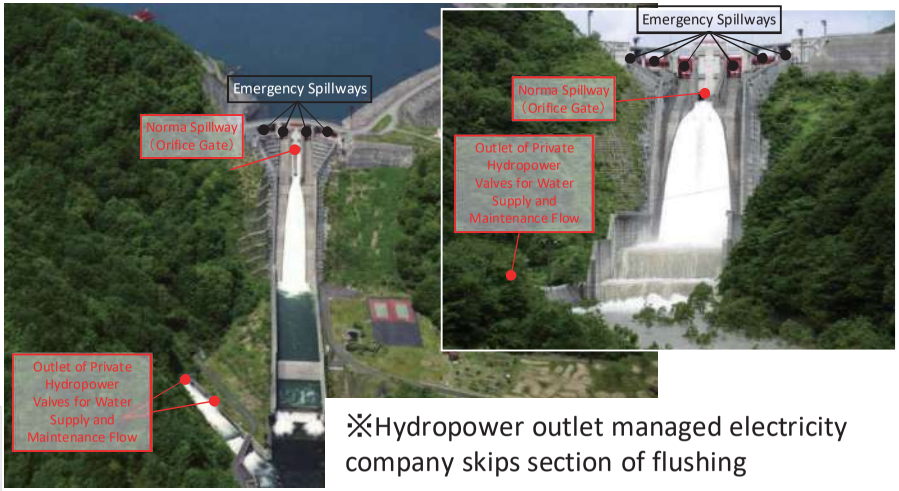
Applicable Capacity

Preparing 1.7million m³ from Flood Control Capacity in the season (16th June to 10th Oct.)



Gates and Valves

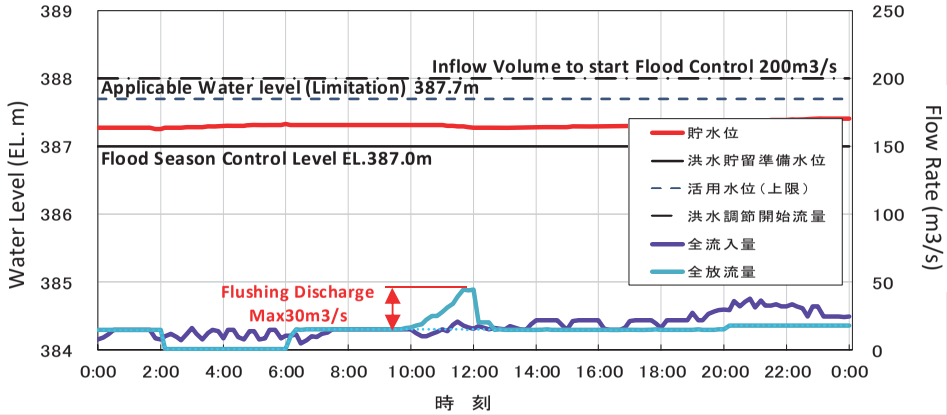
Discharge from Normal Spillway, Valves for Private Hydropower and Water supply to downstream



※Hydropower outlet managed electricity company skips section of flushing

Example

Result of Flushing Discharge on June 2016



Before and After of Flexible Operation

■Before

■After

③Countermeasures for Sedimentation

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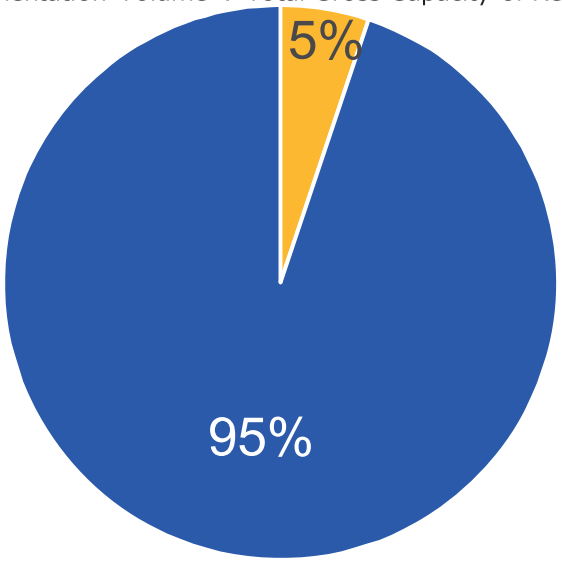
Sedimentation Situation of MLIT's Dams (March, 2017)

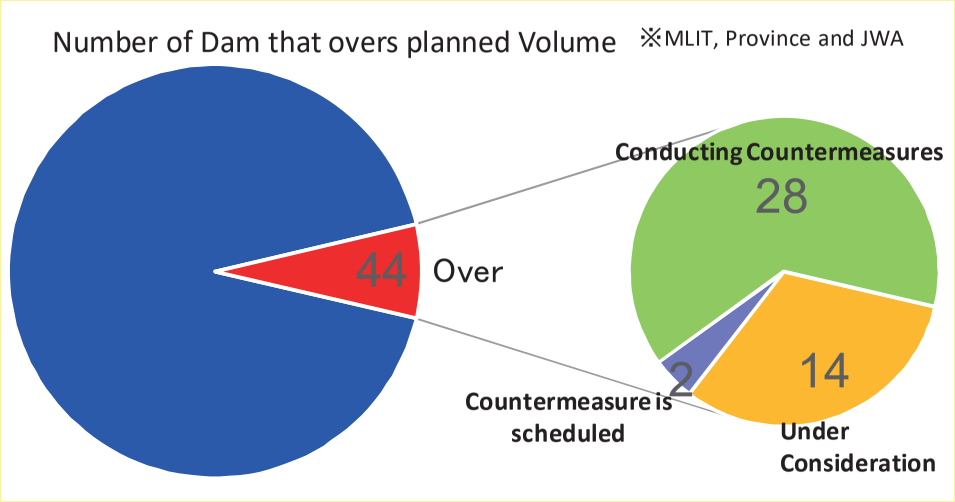
- ●Total rate of sedimentation in all dams of MLIT is approx. 5% against gross capacity of reservoirs
- ●There are some dams that sedimentation overs planned sedimentation and sediment occupies flexibility of flood control capacity. However all of dam conducts or considers countermeasures

◆Sedimentation rate of Gross Capacity of Reservoirs

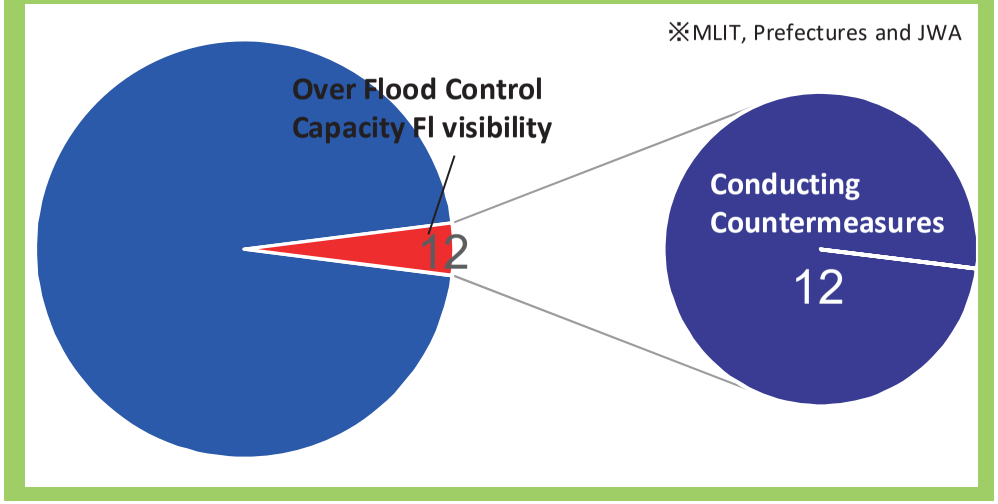
Sedimentation Rate against Gross Capacity of Reservoirs of MLIT, Province and JWA
(Total Sedimentation Volume ÷ Total Gross Capacity of Reservoirs)



◆Against Planned Sedimentation Volume (558 Dams)



◆Sedimentation in Flood Control Capacity (558 Dams)



※Sedimentation data: as of March 2017, Conducting Countermeasures Information: as of July 2018

Basic Policy on Countermeasures for Dam Sedimentation

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- Basically, Capacity of Sedimentation is considered a volume that will be stored for 100 years. Capacity for Flood Control is included 20% margin capacity by consideration of sedimentation.
- Sedimentation is usually planned to remove from reservoir

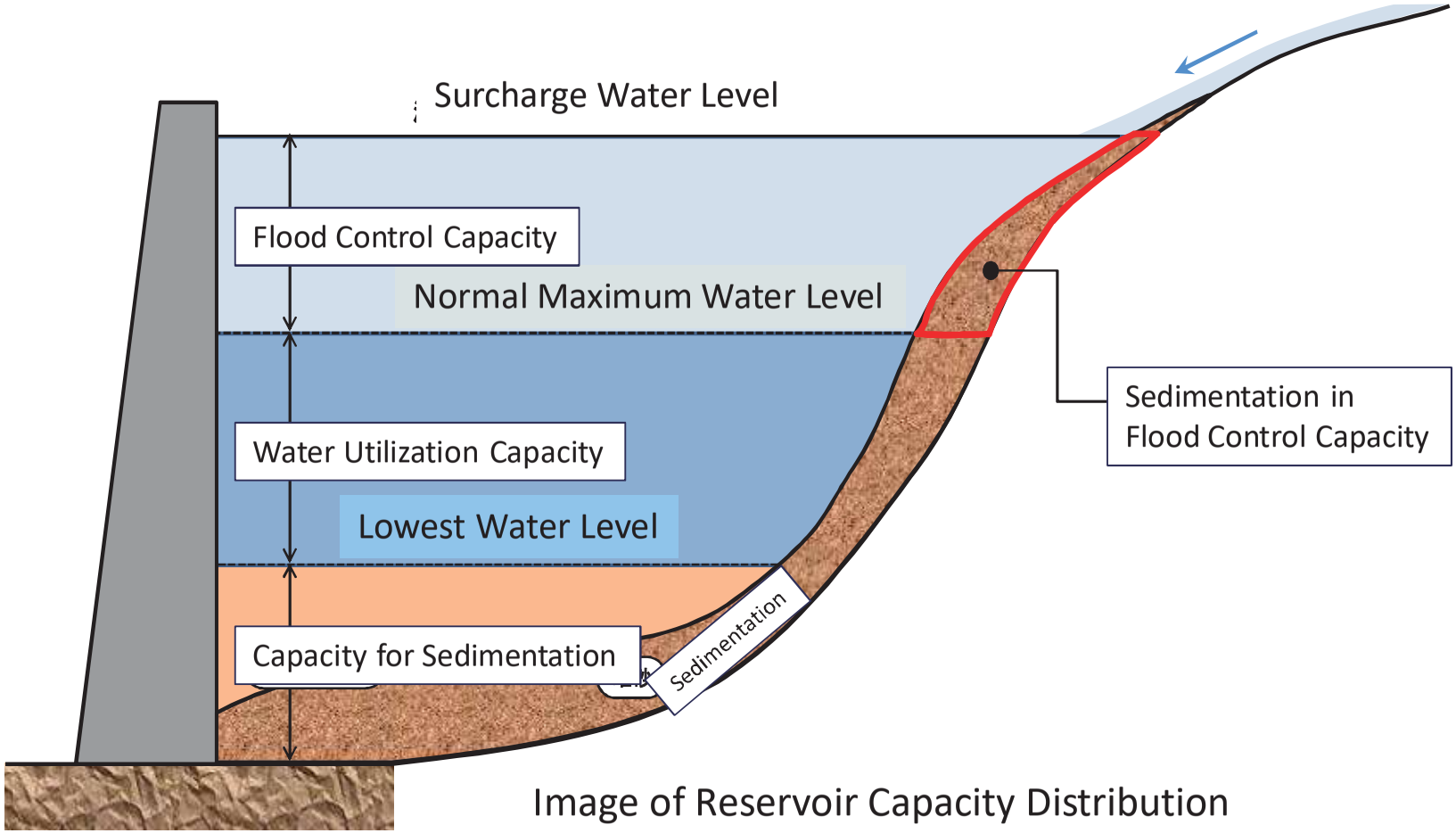

Image of Reservoir Capacity Distribution

A6-3-No.004-140

Countermeasures for Sedimentation

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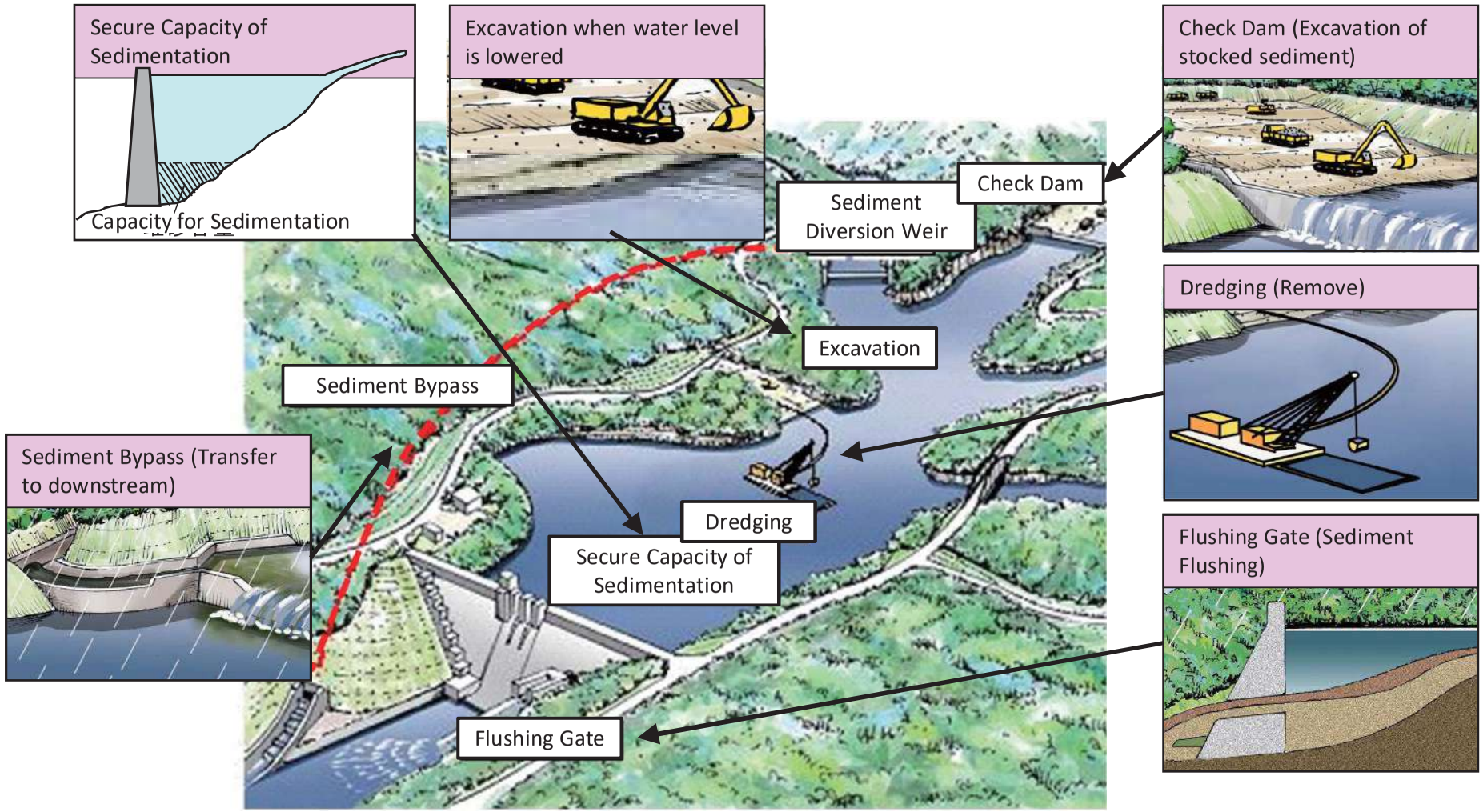
●Countermeasures for Sedimentation is implemented for preservation of reservoir capacity, function of inlet and outlet and inundation at upstream side of reservoir that are caused by sedimentation



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Excavation

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●Excavation when water level is lowered (Yokoyama Dam, Ibi River in Kiso River System)

Check Dam, Excavation

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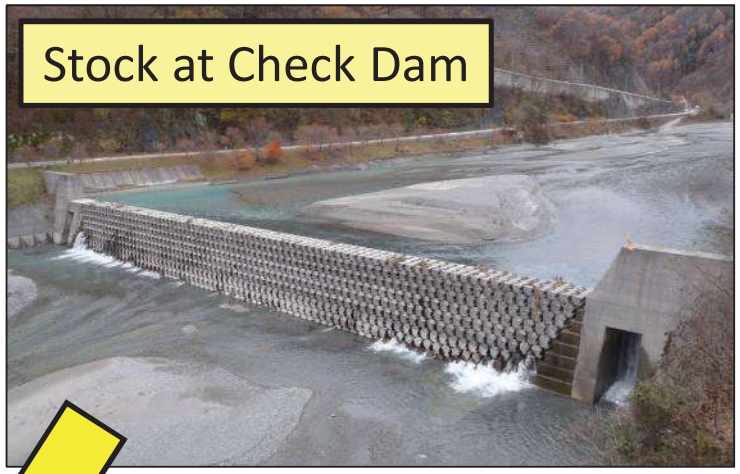
●Excavation of Sediment that is stocked at Check Dam



A6-3-No.004-143

Promoting Installment of Hydropower Plant

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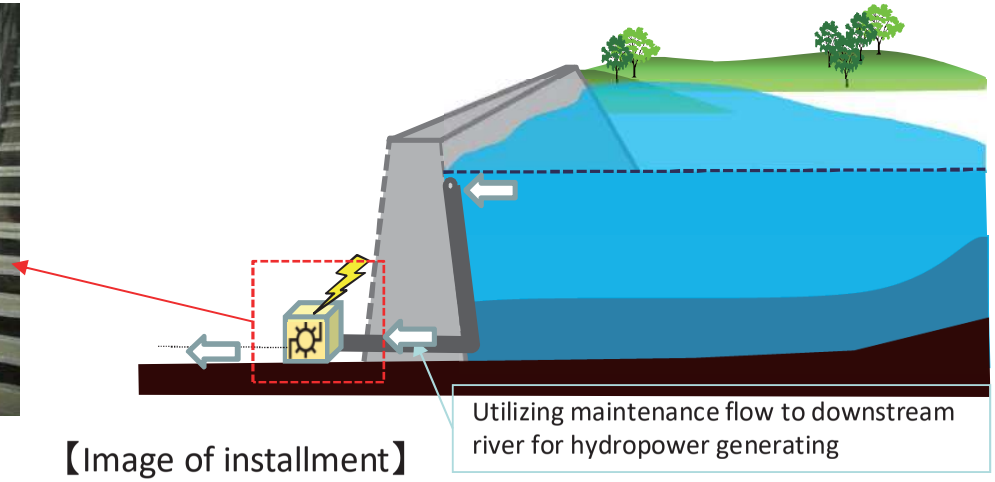
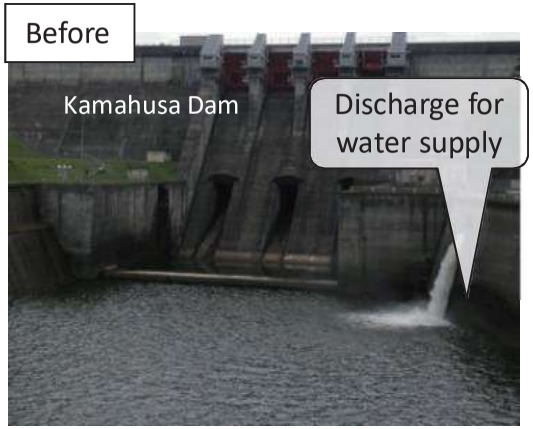
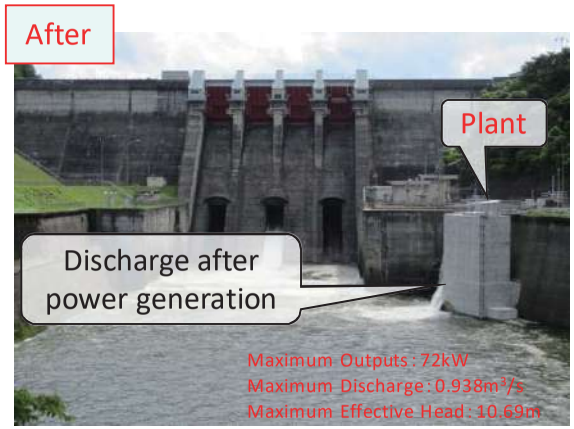
- Hydropower Plants has been installed at dams that are managed by MLIT. Purpose of the plants is for emergency case and supplying power to dam facilities
- Promoting thorough utilization of renewable energy continuously



【Image of installment】





【Example: Kamahusa Dam, Goishi River in Natori River System,Miyagi Prefecture, 】

Actions for Regional Revitalization with Cooperation of Local Government and Community

① Dam Card

② Dam Curry Rice

③ Discharge from Spillway as Inspection

④ Infra-Tourism

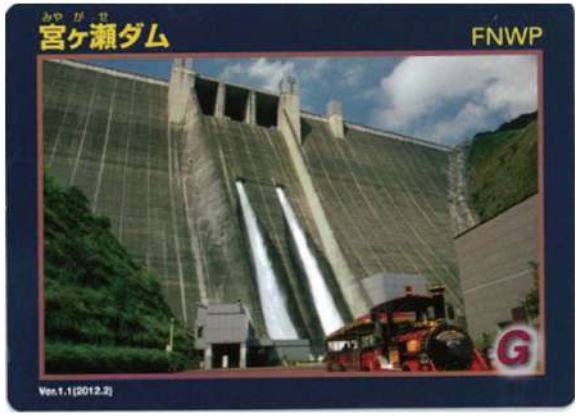
⑤ Recreation Use of Dam Reservoir

⑥ Site Visiting at Dam Constructing Site

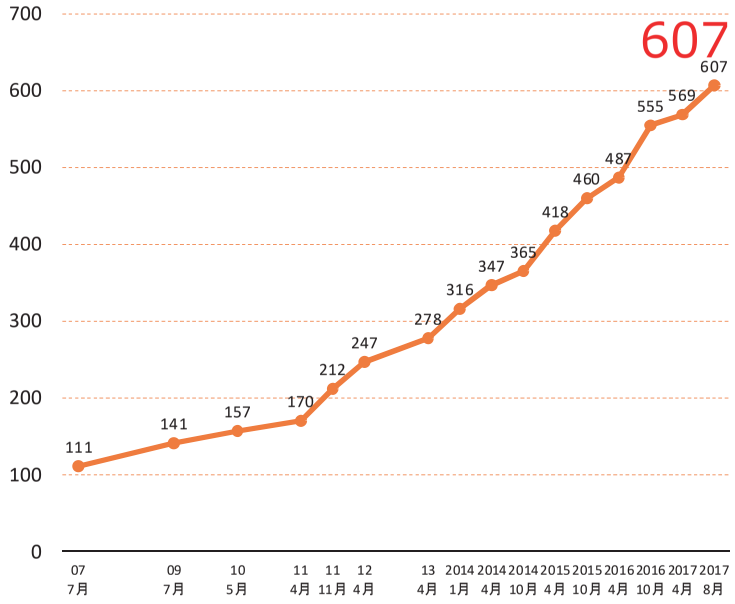
A6-3-No.004-145

①Dam Card

Dam Card mentions not only basic information such as type of dam body, capacity of reservoir, but also specialized technology in the dam. The card can be distributed to visitor at the dam



Basic specifications, episodes and other information are condensed on the card



Transition of number of official Dam Card (as of Aug. 2017)

A6-3-No.004-146

②Dam Curry Rice and Gourmet

【ダム管理者以外が実施】

Increasing Dam Curry Rice in Japan (120 Locations as of July 2017)
It is focused as Revitalization of Dam Area

Tsugaru Dam

Moriyoshizan Dam

Yuda Dam

Naruko Dam

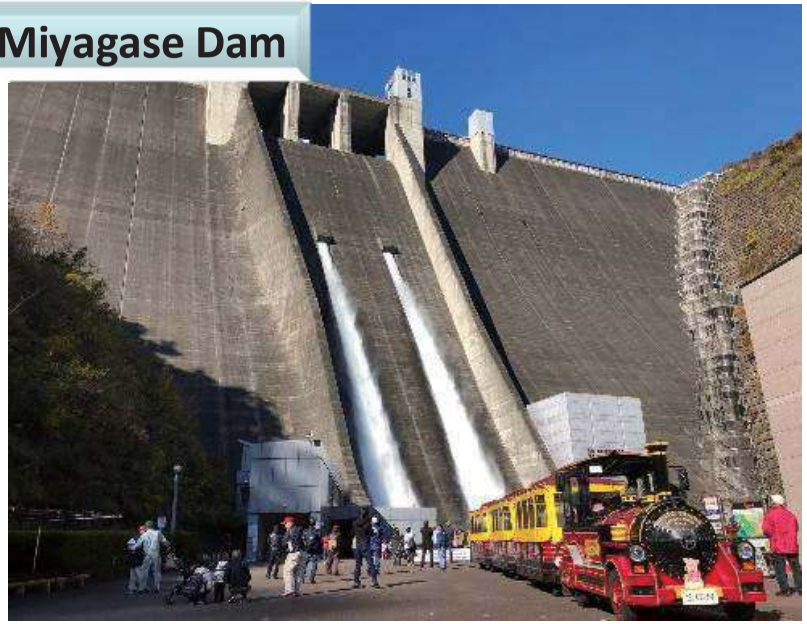
Nagai Dam

Miharu Dam

③Discharge from spillway as Inspection

Yagisawa Dam

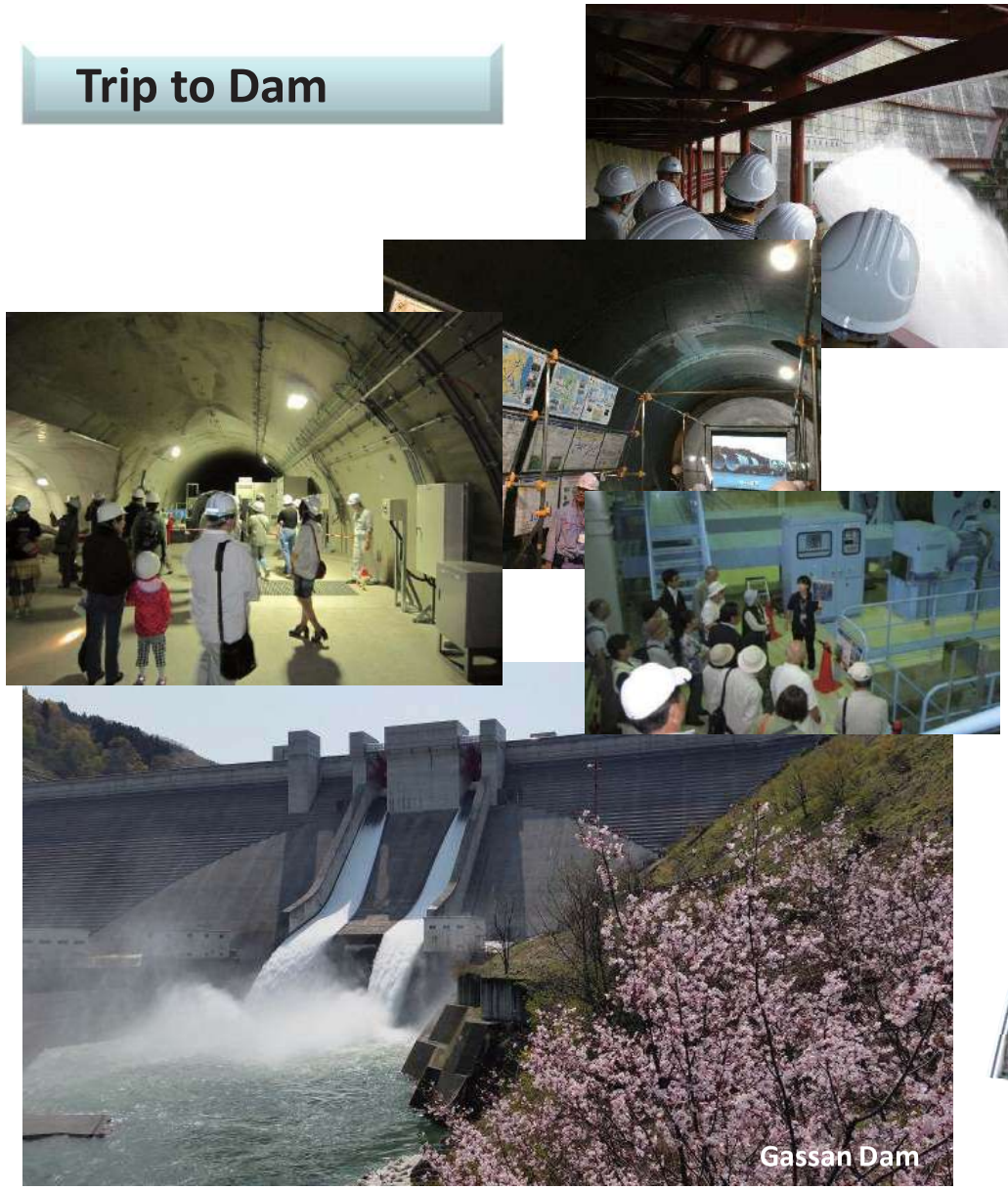
Miyagase Dam



Miyagase Dam(Discharge with night light-up）

④Infra-Tourism

Trip to Dam



Source: Website of Kinki-Nippon Tourist

Advertisement of Private Travel Agent

⑤Recreation Use of Dam Reservoir

Yabakei Dam

Wakeboard, Water-skiing

Ikeda Dam

Rafting

World Competition, Oct. 2017

Sagae Dam

Canoeing Race

Sameura Dam

Flying Boat

The Asian Games, Sep. 2016

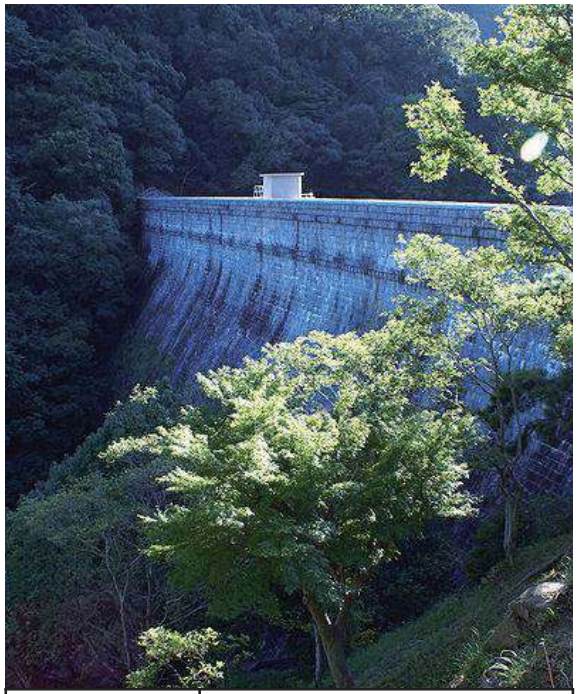
⑥Site Visiting at Dam Constructing Site

Yamba Dam

Type of 1st dam in Japan

- ○Construction of modern type dam has been started since 100 year ago or more
- ○Nunobiki-Gohonmatsu Dam that was constructed in 1900 as 1st concrete dam in Japan is still now functioned as water supply for drinking water
- ○It functions for long time by adequate O/M works that is based on technical standard

1st Gravity Concrete Dam in Japan



Name	Nunobiki-Gohonmatsu Dam
Hight	33.3m
Purpose	Drinking Water
Completion	1900

1st Rock-Fill Dam in Japan

Name	Kobuchi-bousai Pond
Hight	20.5m
Purpose	Flood Control
Completion	1951

1st Arch Concrete Dam in Japan

Name	Minari Dam
Hight	42m
Purpose	Hydropower
Completion	1953

※ダム便覧2014（URL：http://damnet.or.jp/Dambinran/binran/TopIndex.html）
※写真はWikipedia(URL: http://ja.wikipedia.org/wiki)

【Yanase Dam】

It is the oldest dam in all dam that MLIT manages. It started operation from 1954, it already passed for 64 years after started operation

A6-3-No.004-153

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
BALAI WILAYAH SUNGAI SULAWESI I
SNVT PEMBANGUNAN BENDUNGAN SULAWESI I
Jln. MR. A.A. Maramis Kairagi Dua Telp / Fax 0431 - 811621 Manado

PAPARAN HASIL SEMINAR LAPANGAN

OPERASI DAN PEMELIHARAAN BENDUNGAN

WILAYAH KERJA PERUM JASA TIRTA I DAN JASA TIRTA II

JAKARTA – PURWAKARTA - MALANG

APRIL 2018

A6-3-No.004-154

Outline :

2 April 2018
Sub-dit OP Bendungan, Dirjen SDA

3 April 2018
Bendungan Jatiluhur, Purwakarta (PJT II)

5 April 2018
Bendungan Selorejo, Malang (PJT I)

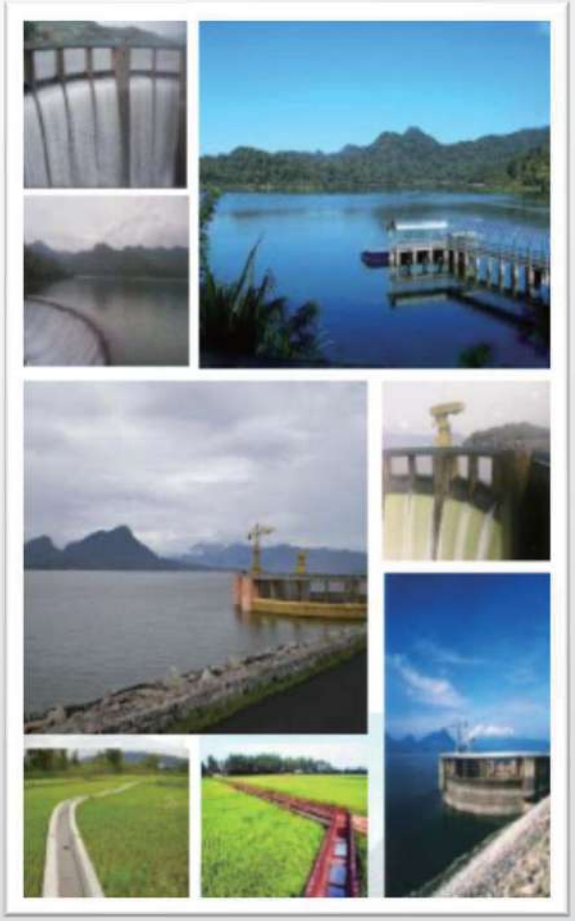
6 April 2018
Bendungan Sengguruh, Sutami, dan Lahor (PJT I)

Expected Result

- Mengetahui status, issue, dan perkembangan OP Bendungan dan Sistem Monitoring Terpusat yang dijalankan oleh PUPR.
- Memahami kerangka kerja administrasi OP Bendungan, terkait Sistem Organisasi, Cost, Budgeting, dan Prosedur Operasi.
- Memahami pekerjaan operasi dan pemeliharaan untuk struktur tubuh bendungan dll, penanganan sedimentasi, termasuk konservasi lingkungan dan dampaknya terhadap kualitas air.
- Dari hasil seminar yang telah terlaksana diharapkan dapat membantu dalam penyusunan manual OP Bendungan Kuwil dan Bendungan Lolak yang nantinya akan beroperasi dibawah pengawasan BWS Sulawesi I.

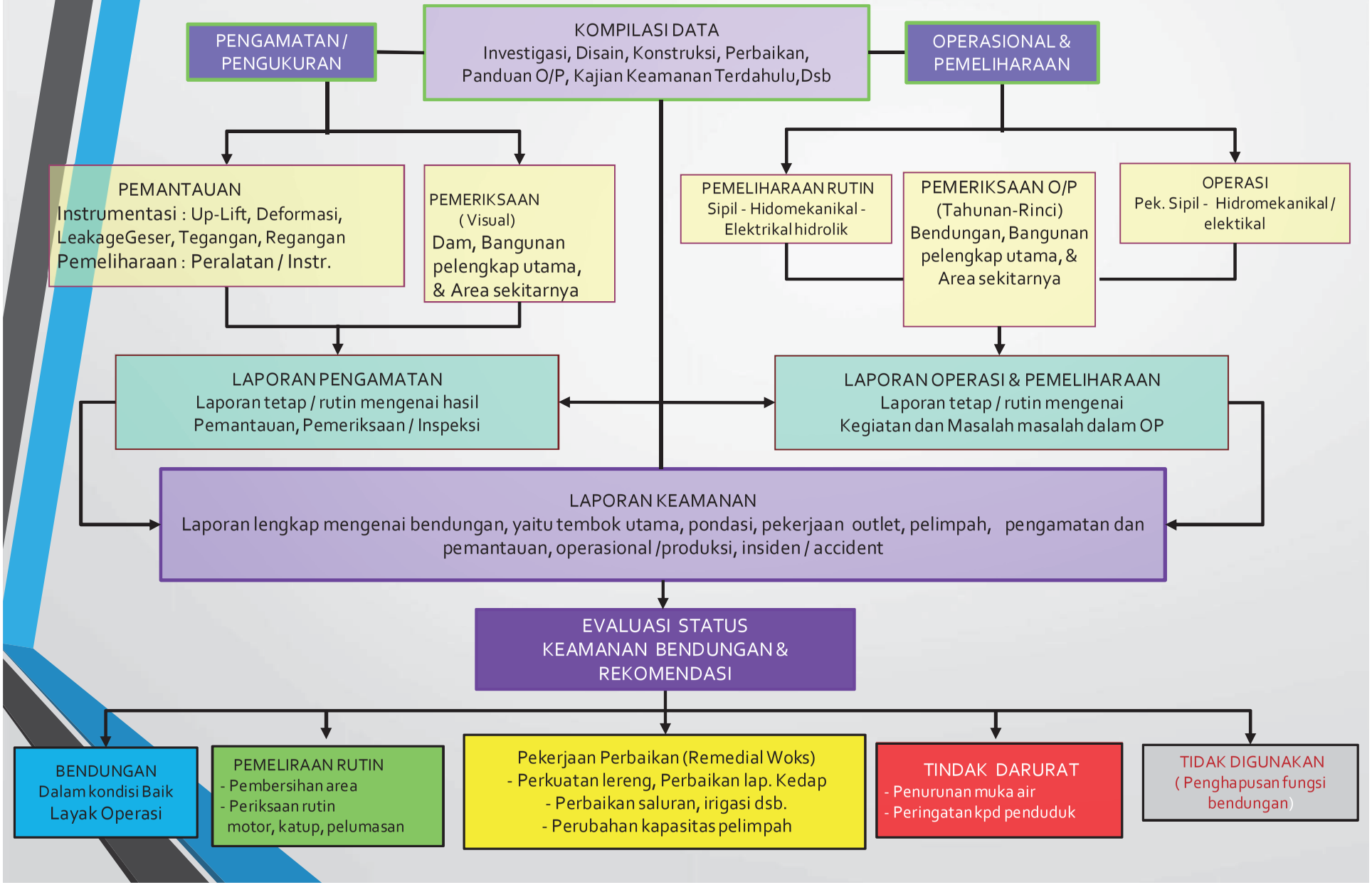
PAPARAN OPERASI DAN PEMELIHARAAN BENDUNGAN DAN DANAU

DIREKTORAT JENDERAL SUMBER DAYA AIR



JAKARTA, 2 APRIL 2018

Cakupan Pekerjaan OP



Konsepsi Keamanan Bendungan

Tugas Unit Pengelolaan Bendungan

Dalam pembentukannya UPB memiliki tanggung jawab pengelolaan Bendungan beserta Waduknya, yang meliputi tugas-tugas sbb :

- Menyusun Rencana Strategi OP untuk 5 tahun anggaran, meliputi pemeriksaan dan OPP rutin maupun berkala, Inspeksi besar, dan Special study.
- Menyusun Canop setiap tahun anggaran dan ROTW.
- Melaksanakan Operasi, Pemeliharaan, dan Pemantauan serta Pengamanan Konstruksi Bendungan.
- Pemutakhiran Rencana Tindak Darurat 5 Tahunan.
- Pemutakhiran Pedoman Pola Operasi dan Pemeliharaan Bendungan beserta Waduknya 5 Tahunan.
- Menyusun SOP dan Manual OP untuk Petugas UPB dan OPP.

Dokumen-Dokumen yang dimiliki UPB

UPB dalam menjalankan tugasnya dalam pengelolaan bendungan akan menerima 14 Dokumen yang nantinya disiapkan oleh Pihak Pembangun dan diserahkan pada masa Persiapan Operasi dan Pemeliharaan (POP) meliputi dokumen berikut:

1. Izin Penggunaan Sumber Daya Air (Ps 10)
2. Persetujuan Prinsip Pembangunan Bendungan (Ps 16) 5 Th
3. Persetujuan Desain Bendungan (Ps 24)
4. Studi Pengadaan Tanah dan Pemukiman Kembali (Ps 26)
5. Izin Pelaksanaan Konstruksi Bendungan (Ps 30) 3 Th
6. Rencana Pengelolaan Bendungan
7. Pedoman Operasi dan Pemeliharaan Bendungan Beserta Waduknya
8. Pola Operasi Waduk 5 Tahun (Ps 45, 46, dan 47)
9. Rencana Tindak Darurat (Ps 53)
10. Izin Pengisian Awal Waduk (Ps 64)
11. As Built Drawing Konstruksi Bendungan
12. Laporan Akhir Pelaksanaan Konstruksi Bendungan (Ps 90)
13. Izin Operasi Bendungan (Ps 92)
14. Penetapan Status Penggunaan (PSP)

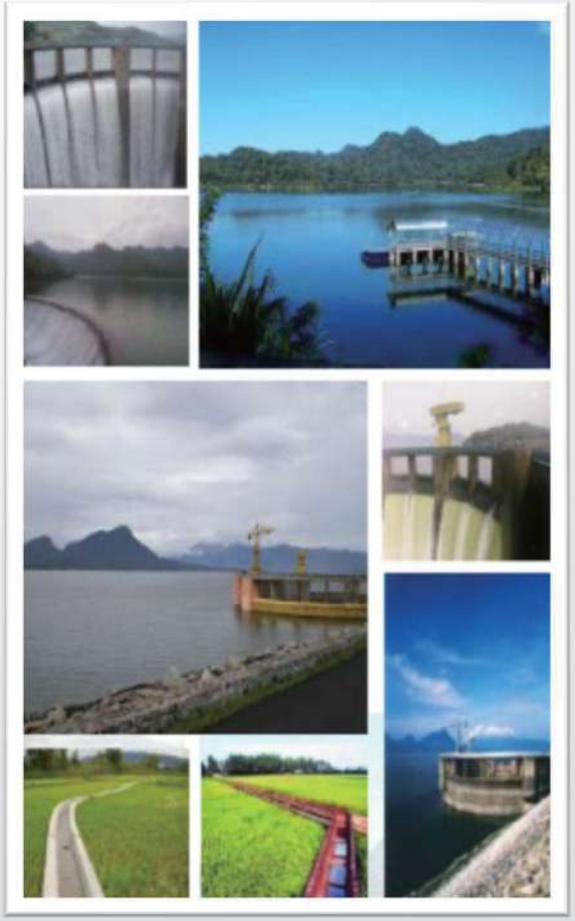
Gambar 1. Paparan singkat Sistem Monitoring Terpusat yang dijalankan oleh Subdit OP Bendungan, PUPR.

Gambar 2. Foto bersama Kepala dan Staff Subdit OP Bendungan, PUPR.

PAPARAN OPERASI DAN PEMELIHARAAN BENDUNGAN IR. H. JUANDA JATILUHUR

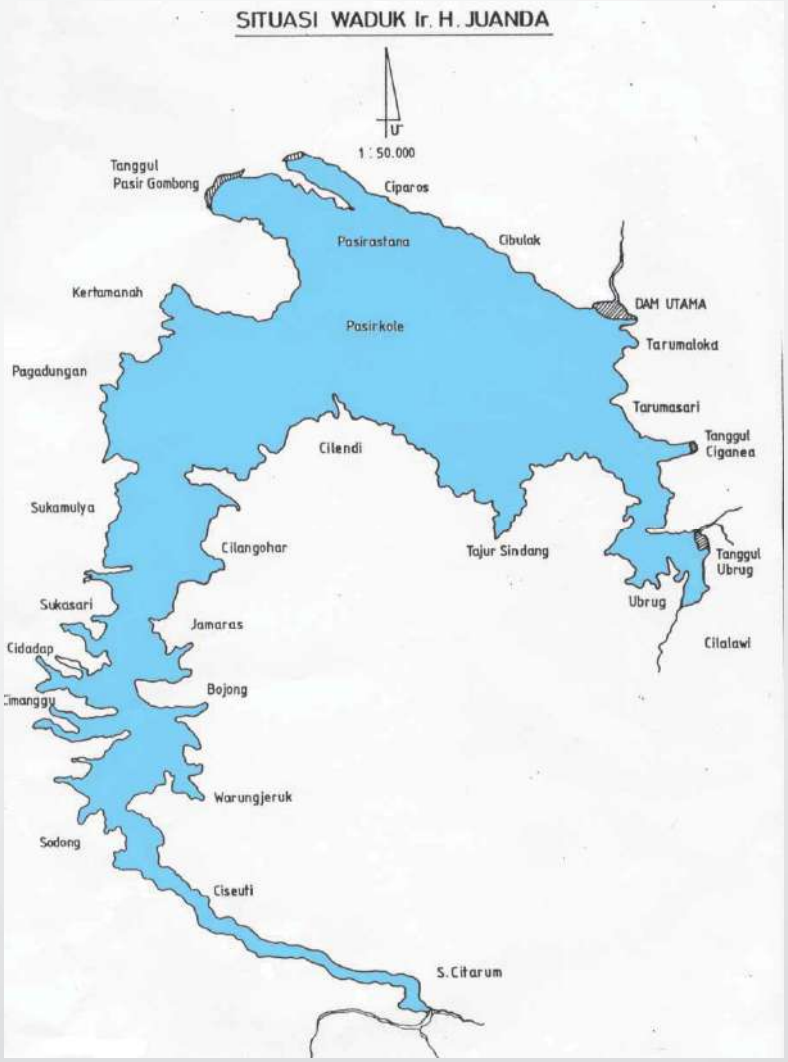
PERUM JASA TIRTA II

PURWAKARTA, 3 APRIL 2018



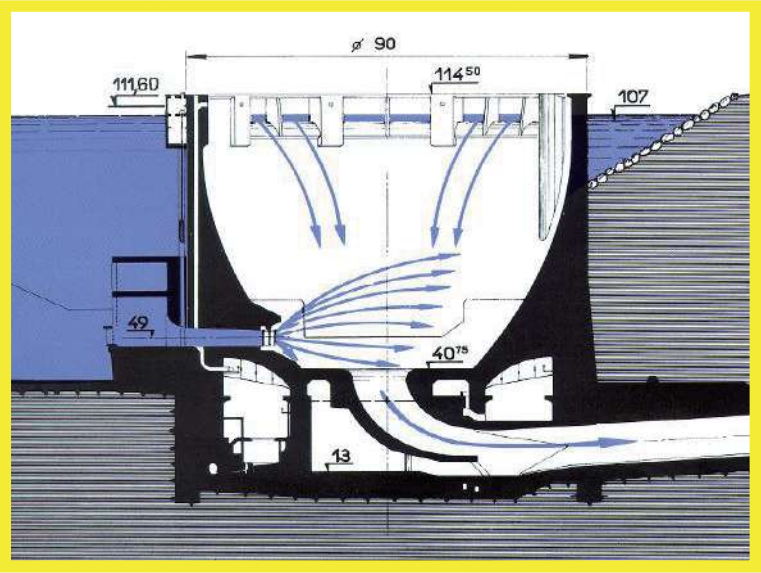
Data Teknis Bendungan Ir. H. Djuanda

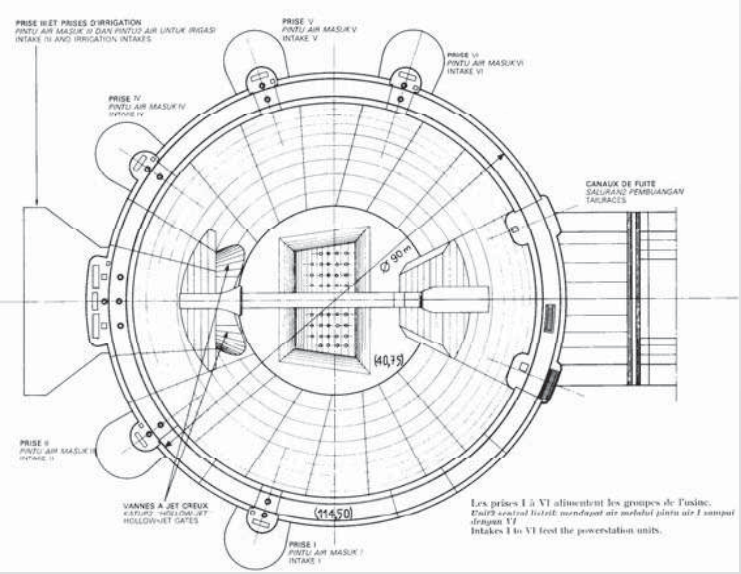
- Kapasitas tampungan waduk ±3 Miliar m^3.
- Tipe bendungan urugan batu dengan inti tanah liat miring.
- Tinggi puncak bendungan 100 meter
- Panjang bentang bendungan 1.200 meter.
- Elevasi puncak +114,50 mdpl.
- Luas genangan ±83 km^2.
- Tanggul Pelana, meliputi :
  1. Pasir Gombong Barat (1.950 m)
  2. Pasir Gombong Timur (400 m)
  3. Ciganea (330 m)
  4. Ubrug (550 m) dengan Emergency Spillway berkapasitas 2.000 m^3/s.



Data Teknis Bendungan Ir. H. Djuanda

- Struktur bangunan pelimpah tipe *Morning Glory*, berbetuk silinder dengan diameter 90 meter dan tinggi 110 meter.
- Elevasi puncak pelimpah +107,00 mdpl.
- Kapasitas pelimpah 3.000 m³/s.
- Memiliki 2 buah pintu *Hollow Jet,* masing-masing berkapasitas 270 m³/s.
- Memiliki 6 buah pintu pengambilan penggerak turbin pembangkit tenaga listrik.





Pengelolaan dan Pemanfaatan Bendungan Ir. H. Djuanda

Kegiatan Operasi dan Pemeliharaan Bendungan Ir. H. Djuanda

Kegiatan Operasi :

- **Perhitungan realisasi air masuk dan air keluar harian**
- **Operasi unit pembangkit PLTA berdasarkan kebutuhan air di hilir**
- **Rapat evaluasi pelaksanaan operasi internal PJT II (15 harian)**
- **Rapat evaluasi pelaksanaan operasi waduk cascade Citarum (Bulanan)**

Kegiatan Operasi dan Pemeliharaan Bendungan Ir. H. Djuanda

Kegiatan Pemeliharaan :

Pemantauan instrumentasi keselamatan bendungan.

(terjadwal)

Pemeliharaan kebersihan lingkungan.

(rutin)

Pemeriksaan visual, tailrace, dan bathymetri.

(berkala)

Pemeliharaan pompa pengering tailrace, katup hollow jet, perapihan riprap, dan kegiatan konservasi.

(berkala)

Gambar 1. Paparan singkat Sistem Operasi dan Pemeliharaan Bendungan Jatiluhur yang dikelola oleh Perum Jasa Tirta II.

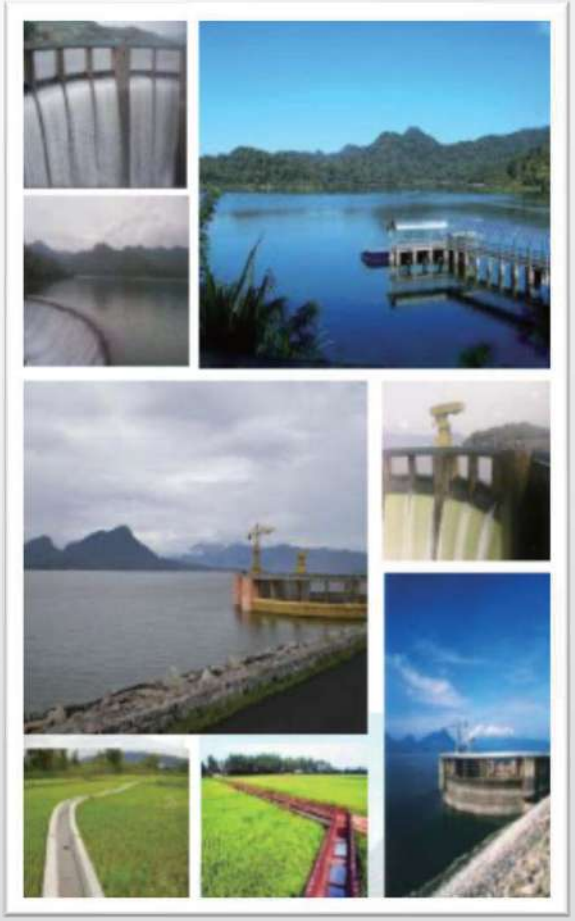
Gambar 2. Penjelasan Sistem Pengoperasian Pintu Air yang ada di Menara Pelimpah (*Morning Glory*).

Gambar 3. Peninjauan area konservasi dan penanganan keramba ikan ilegal yang ada di Bendungan Jatiluhur

Gambar 4. Kunjungan ke Power House PLTA Ir. H. Juanda.

PENGELOLAAN SDA SECARA TERPADU DAN MANAJEMEN SEDIMENTASI UNTUK MENUNJANG KEBERLANJUTAN FUNGSI DAN MANFAAT INFRASTRUKTUR SDA

PERUM JASA TIRTA I



MALANG, 5 - 6 APRIL 2018

PJT 1 Sebagai Badan Pengelolaan Wilayah Sungai

Perum Jasa Tirta I (PJT-I) adalah BUMN yang diberi sebagian dari kewenangan Pemerintah dalam pengelolaan sumber daya air di Wilayah Sungai Brantas dan Bengawan Solo. Tugas pengelolaan PJT-I diatur dalam PP No. 46 Tahun 2010 yang mencakup kegiatan operasi dan pemeliharaan preventif dari prasarana pengairan dan pengusahaan jasa air.

Layanan PJT-1 sesuai PP No. 46 Thn 2010 dan Keppres No. 2 Thn 2014, meliputi :

5 Wilayah Sungai → 7 Divisi, 749 Pegawai → 7.430 GWh energi → 1.5 juta ha lahan irigasi → 650 juta m^3, Air baku domestic dan industri

Kegiatan Operasi dan Pemeliharaan Terpadu SDA oleh PJT-1

Kegiatan Operasi :

- **Pemberian air waduk sesuai alokasi**
- **Pemantauan hidrologi**
- **Kalibrasi dan pemantauan pengukuran**
- **Instrumentasi keamanan bendungan (*pore pressure, ground water level, settlement*, dsb)**

Kegiatan Operasi dan Pemeliharaan Terpadu SDA oleh PJT-1

Kegiatan Pemeliharaan :

Pemeriksaan Infrastruktur dan tubuh bendungan (pelimpah, intake, pintu air, dsb)

Pemeriksaan dan pemeliharaan Instrumen dan Hidromekanikal

Konservasi daerah/wilayah tangkapan air waduk dan sungai

Pemeliharaan sarana pendukung (jalan puncak /inspeksi, system pematusan, dsb)

Kegiatan Operasi dan Pemeliharaan Terpadu SDA oleh PJT-1

Kegiatan Terpadu PJT-I :

Pengelolaan hidrologi dengan telemetering system memanfaatkan Jaringan GSM dan Web Based Application.

Sistem peringatan dini banjir berbasis masyarakat di wilayah sungai brantas.

Konservasi rutin sungai brantas dengan melibatkan kearifan lokal, pemangku kepentingan, dan komunitas masyarakat

Pengendalian sampah, gulma air, dan kualitas air secara online maupun offline.

Permasalahan Sedimentasi DAS yang dihadapi oleh PJT-1

Persoalan laju Sedimentasi pada daerah aliran sungai brantas utamanya dipengaruhi oleh beberapa faktor, meliputi :

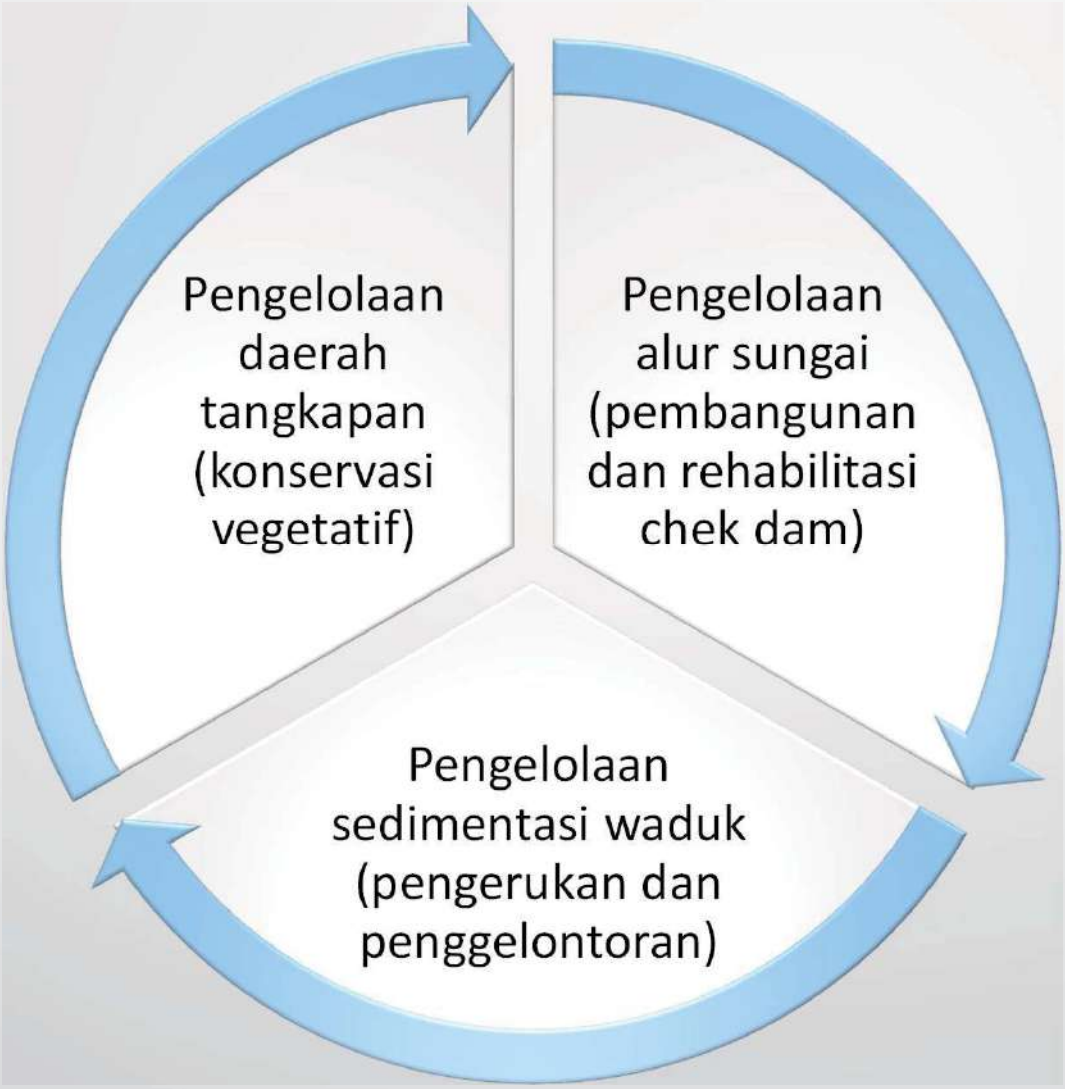
A ♣ Perubahan tutupan hutan, dimana perkebunan dan pertanian berkontribusi besar pada luasan deforestasi.

2 ♣ Gunung berapi memainkan peranan besar dalam menciptakan deposit sedimen, dimana topografi DAS Brantas terletak diantara dua gunung berapi aktif, yaitu Gunung Kelud dan Gunung Semeru.

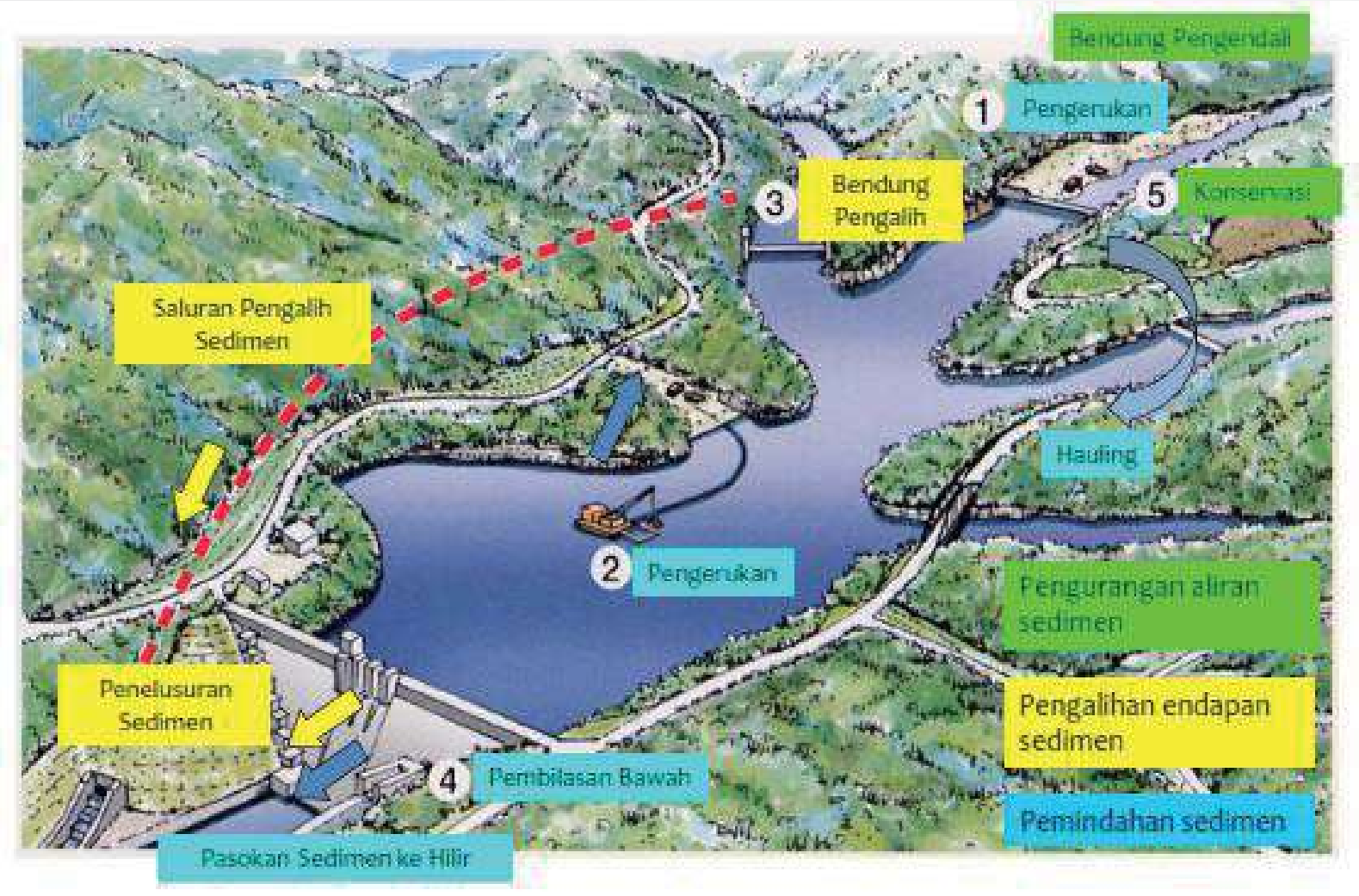
3 ♣ Metode pertanian yang pengelolaannya tidak ramah lingkungan, peladangan terbuka pada kawasan kritis, mempercepat degradasi.

4 ♣ Erosi lahan yang konsekuensinya meningkatkan sedimentasi pada perairan terbuka, sungai, danau, dan waduk buatan manusia.

Penanganan Sedimentasi yang dilaksanakan oleh PJT-1



Skema penanganan Sedimentasi yang dilaksanakan oleh PJT-1



Kegiatan terpadu penanganan Sedimentasi yang dilaksanakan oleh PJT-1

Pembuatan Resapan Air Pengendali Erosi dan Sedimentasi (RAPES)

Kegiatan terpadu penanganan Sedimentasi yang dilaksanakan oleh PJT-1

Bangunan Pengendali Erosi Berkonsep *Eco-efficiency*

Kerja sama PJT I dengan *UNESCAP* di Kabupaten Malang

Kegiatan terpadu penanganan Sedimentasi yang dilaksanakan oleh PJT-1

Pembuatan Perlindungan Tebing Sungai

Kegiatan terpadu penanganan Sedimentasi yang dilaksanakan oleh PJT-1

Penghijauan

Penghijauan daerah tangkapan hujan

Penghijauan Greenbelt Bendungan Sutami

Penghijauan daerah hulu

Konservasi Sumber air

Reboisasi

Gambar 1. Paparan singkat Sistem Operasi dan Pemeliharaan Bendungan dan DAS yang dikelola oleh Perum Jasa Tirta I.

Gambar 2. Penjelasan Sistem Pengoperasian & Pengamatan alat Instrumentasi bendungan Selorejo.

Gambar 3. Proses Pengerukan sampah dan sedimentasi yang ada di bendungan sengguruh.

Gambar 4. Observasi dan peninjauan kondisi rekahan (crack) yang terjadi di puncak tubuh bendungan Sutami.

Gambar 5. Observasi dan peninjauan control room Bendungan Sutami oleh Tim Teknis PJT-I.

Gambar 6. Paparan singkat kegiatan operasi dan pemeliharaan Bendungan Lahor oleh PJT-I.

Kesimpulan

Kesimpulan yang dapat diambil dari kegiatan On the Job Training yang telah terlaksana untuk selanjutnya dapat diterapkan di Proyek Bendungan Kuwil dan Bendungan Lolak adalah meliputi hal-hal sebagai berikut :

- Perlu adanya perencanaan dan persiapan draft rancangan OP bendungan yang matang dan tersinergi untuk dapat mendukung system monitoring terpusat yang sedang dijalankan oleh Subdit OP bendungan, PUPR.
- Perlu adanya kajian lebih lanjut terkait potensi laju sedimentasi yang ada di Bendungan Kuwil dan Bendungan Lolak sehingga dapat dilakukan tindakan pencegahan maupun penanganan yang tepat sehingga masa layan dari kedua Bendungan tersebut dapat dioptimalkan.

TERIMA KASIH

KEMENTERIAN PEKERJAAN UMUM & PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
DIREKTORAT BINA OPERASI DAN PEMELIHARAAN

SUBDIT OP BENDUNGAN DAN DANAU

Manado, 25 April 2018

A6-3-No.004-188

RENCANA STRATEGIS

VISI & MISI PRESIDEN → **RPJMN 2015-2019**

NAWACITA

DIMENSI PEMBANGUNAN 1	DIMENSI PEMBANGUNAN 2	DIMENSI PEMBANGUNAN 3
SDM	**PEMBANGUNAN SEKTOR UNGGULAN DENGAN PRIORITAS KEDAULATAN PANGAN & ENERGI**	PEMERATAAN & KEWILAYAHAN

KEMEN-PUPR

VISI

"TERWUJUDNYA INFRASTRUKTUR PEKERJAAN UMUM DAN PERUMAHAN RAKYAT YANG HANDAL DALAM MENDUKUNG INDONESIA YANG BERDAULAT, MANDIRI, DAN BERKEPRIBADIAN BERLANDASKAN GOTONG ROYONG"

MISI

MEMPERCEPAT PEMBANGUNAN INFRASTRUKTUR SUMBERDAYA AIR TERMASUK SUMBER DAYA MARITIM UNTUK MENDUKUNG KETAHANAN AIR, KEDAULATAN PANGAN, DAN KEDAULATAN ENERGY

DITJEN SDA

PROGRAM PRIORITAS

1. **Pembinaan Waduk, Embung, dan Bangunan Penampung Air Lainnya**
2. **Pembinaan Operasi dan Pemeliharaa**n Sumber Daya Air
3. Pembinaan Keamanan Bendungan*)
4. Pengelolaan dan Konservasi Sungai, **Waduk, Embung, Situ, serta Bangunan Penampung Air Lainnya**

TUGAS & FUNGSI

TUGAS DAN FUNGSI OP BENDUNGAN & DANAU

TUGAS & FUNGSI

- Pembinaan Pelaksanaan NSPK
- Bimbingan Teknis & Supervisi Pelaksanaan OP Bendungan & Danau
- Pembinaan Kesiapan OP Sarpras Bendungan & Danau
- Pembinaan Pemberdayaan Masyarakat
- Pembinaan Teknis Pengelolaan SDA kpd Badan Usaha bid. Bendungan & Danau
- Penyelenggaraan Audit Teknis bidang OP Bendungan & Danau
- Pengendalian Pelaksanaan Kegiatan OP Bendungan & Danau

TARGET/SASARAN

PEMBINAAN

- **Penguatan Kelembagaan UPB**
- **Peningkatan SDM Pengelola Bendungan**
- **Terobosan Pengelolaan Bendungan/Embung**
  - **Pengelolan Embung mandiri/oleh kelompok masyarakat**
- **Regulasi**
  - **PROM/POP, Sertifikasi Izin Operasi; Sertifikasi Keahlian; Sempadan Danau**

PELAKSANAAN

- **Penilaian Kinerja Bendungan, Danau, Embung/Situ**
- **Monitoring & Evaluasi secara komprehensif**

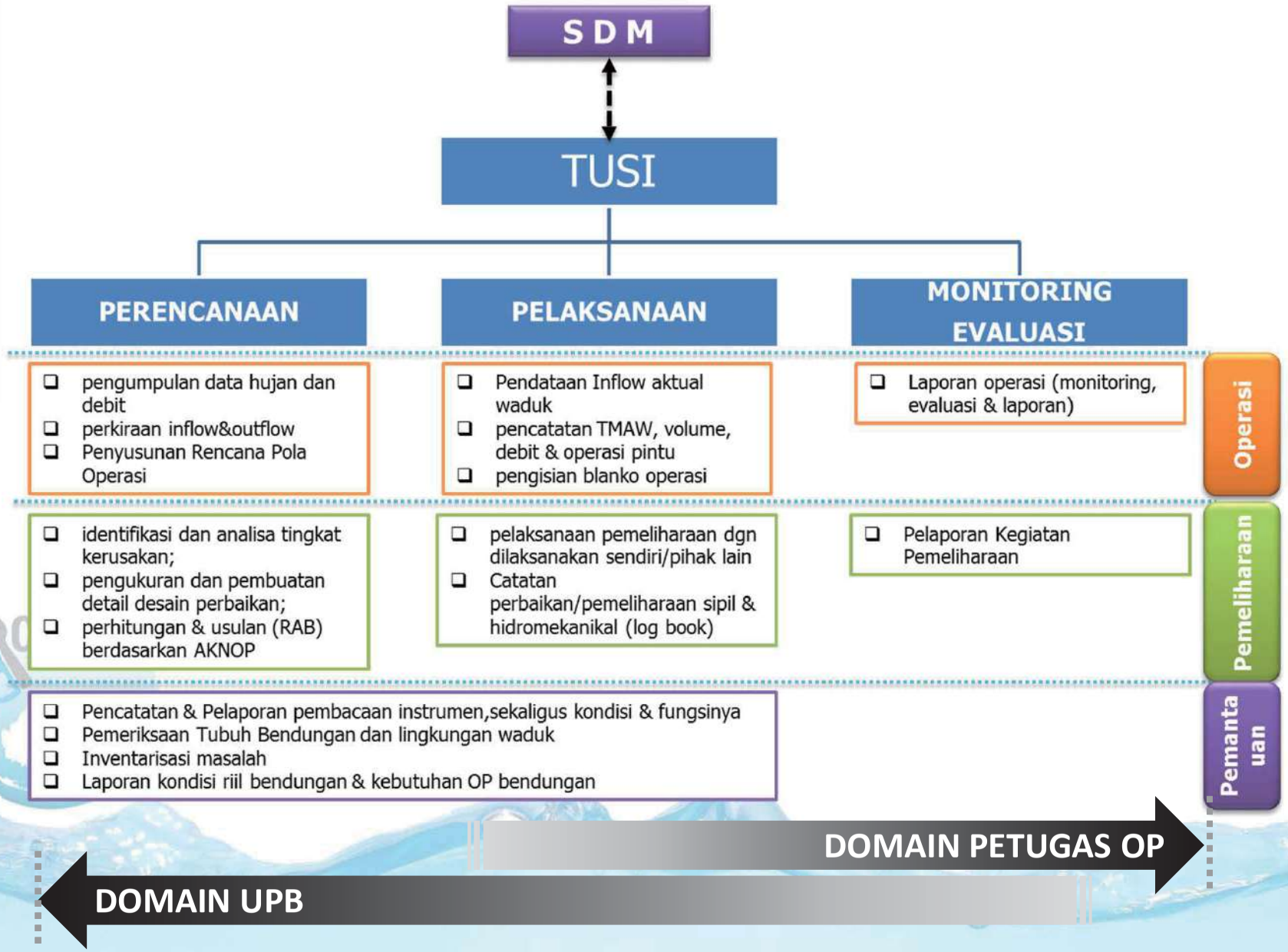
Terobosan : Pengelolaan Bendungan/Embung yang berbasis peran serta masyarakat secara mandiri

EVALUASI

- Perlu tenaga tetap di UPB yang sesuai baik secara kalitatif maupun kuantitatif untuk menjalankan tusi pengelolaan bendungan
- Perlu evaluasi/screening kecukupan sarpras(kantor, sekretariat); personel; dan alokasi dana
- Peningkatan kuallitas SDM pengelola bendungan (sertifikasi, bimbingan teknis)

U P B

Kaitan SDM dengan Tusi Pengelolaan Bendungan



ISU PRIORITAS OP BENDUNGAN & DANAU

- Persiapan OP (PROM/POP)
- Outcome Bendungan
- Status/pengelolaan aset Bendungan
- Pengelolaan Bendungan
  a. Manual OP, Pola Operasi, RTD, Inspeksi, Izin Operasi, SDM, Sarpras
  b. Perlu terobosan/inovasi dalam pengelolaannya
  c. Pelibatan peran serta masyarakat dalam pengelolaan waduk
- Keterbatasan SDM (kualitas/kuantitas) Petugas OP
- Keterbatasan Tenaga dan Waktu KKB/BB
- Penguatan kelembagaan UPB dalam pengelolaan bendungan (Regulasi, SDM, maupun sarana & prasarana)

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3. UNIT PENGELOLA BENDUNGAN (UPB)

A6-3-No.004-194

PEMILIK BENDUNGAN PEMERINTAH PUSAT (Ps 77)

- PENGELOLAAN BENDUNGAN BESERTA WADUKNYA MENJADI TANGGUNG JAWAB PEMILIK
- PEMERINTAH PUSAT SEBAGAI PEMILIK, MENTERI MENUNJUK UNIT PELAKSANA TEKNIS YANG MEMBIDANGI SUMBERDAYA AIR ATAU BUMN SEBAGAI PENGELOLA BENDUNGAN
- PENGELOLA BENDUNGAN DALAM MELAKSANAKAN PENGELOLAAN BENDUNGAN BESERTA WADUKNYA DIBANTU OLEH UNIT PENGELOLA BENDUNGAN (UPB)
- UPB DITETAPKAN OLEH PEMILIK ATAU PENGELOLA BENDUNGAN
- PENGELOLA BENDUNGAN BUMN, PENETAPAN UPB OLEH DIREKSI

DASAR HUKUM PEMBENTUKAN UPB DILINGKUNGAN DITJEN SDA KEMENT PUPR

- UU NOMOR 11 TAHUN 1974 tentang PENGAIRAN
- UU NOMOR 23 TAHUN 2014 tentang PEMERINTAHAN DAERAH
- Permen PUPR nomor : 27/PRT/M/2015 tanggal 20 Mei 2015 tentang BENDUNGAN diundangkan oleh Menteri KUMHAM tanggal 25 Mei 2015 dan dimuat dalam Berita Negara Republik Indonesia tahun 2015 nomor 771
- Permen PUPR nomor : 20/ PRT/ M/ 2016 tentang organisasi dan tata kerja UPT di Kementerian PUPR

UNIT PENGELOLA BENDUNGAN (UPB)

- PENANGGUNG JAWAB UPB ADALAH KEPALA BALAI (Permen PUPR nomor : 20/ PRT/ M/ 2016)
- KEPALA UPB melekat pada struksur organisasi Balai yaitu untuk BBWS dijabat oleh KEPALA BIDANG OP dan untuk BWS dijabat oleh KEPALA SEKSI OP / KEPALA SEKSI PERENCANAAN DAN OP (Permen PUPR nomor : 20/ PRT/ M/ 2016)
- Unit data dan Evaluasi untuk BBWS dijabat oleh KEPALA SEKSI PERENCANAAN OP dan untuk BWS dijabat oleh PPK OP SDA 1 yang dibantu petugas bidang program, evaluasi, dan pelaporan untuk kegiatan operasi, pemeliharaan, dan pemantauan

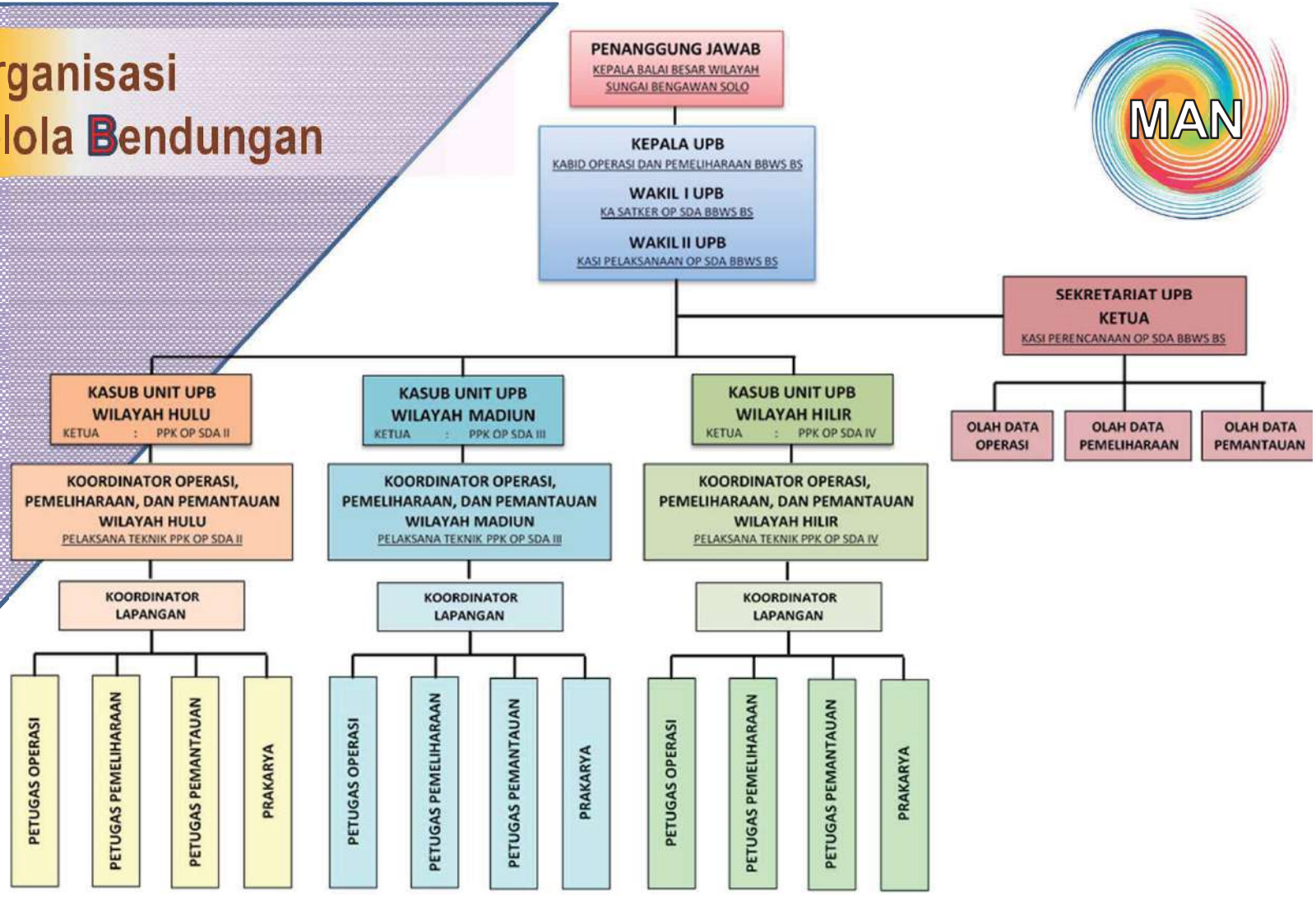
UNIT PENGELOLA BENDUNGAN (UPB)

- WAKIL KEPALA UPB I untuk BBWS dan BWS dijabat oleh KEPALA SATUAN KERJA OP dengan pertimbangan yang bersangkutan sebagai penanngungjawab dana untuk kegiatan UPB
- WAKIL KEPALA UPB II untuk BBWS dijabat oleh KEPALA SEKSI PELAKSANAAN OP
- KEPALA SUB UPB dijabat oleh PPK OP SDA sebagai penanggung jawab anggaran kegiatan Operasi dan Pemeliharaan
- WAKIL KEPALA SUB UPB dijabat oleh PETUGAS yang kompeten dibidang bendungan.

UNIT PENGELOLA BENDUNGAN (UPB)

- DISETIAP BENDUNGAN ADA PETUGAS OPERASI DAN PEMELIHARAAN YANG MELAKSANAKAN KEGIATAN OPERASI, PEMELIHARAAN DAN PEMANTAUAN SERTA UNIT KEAMANAN YANG DIKOORDINIR OLEH SEORANG KOORDINATOR
- APABILA DIDALAM WS ADA OPERATOR BENDUNGAN (BUMN, BUMD, BU), MASING MASING OPERATOR WAJIB MEMBENTUK UPB
- DALAM PENYUSUNAN DAN PELAKSANAAN ROTW untuk OPERASI WADUK BERKOORDINASI DENGAN UPB BALAI

Struktur Organisasi Unit Pengelola Bendungan



TUGAS UNIT PENGELOLA BENDUNGAN (UPB)

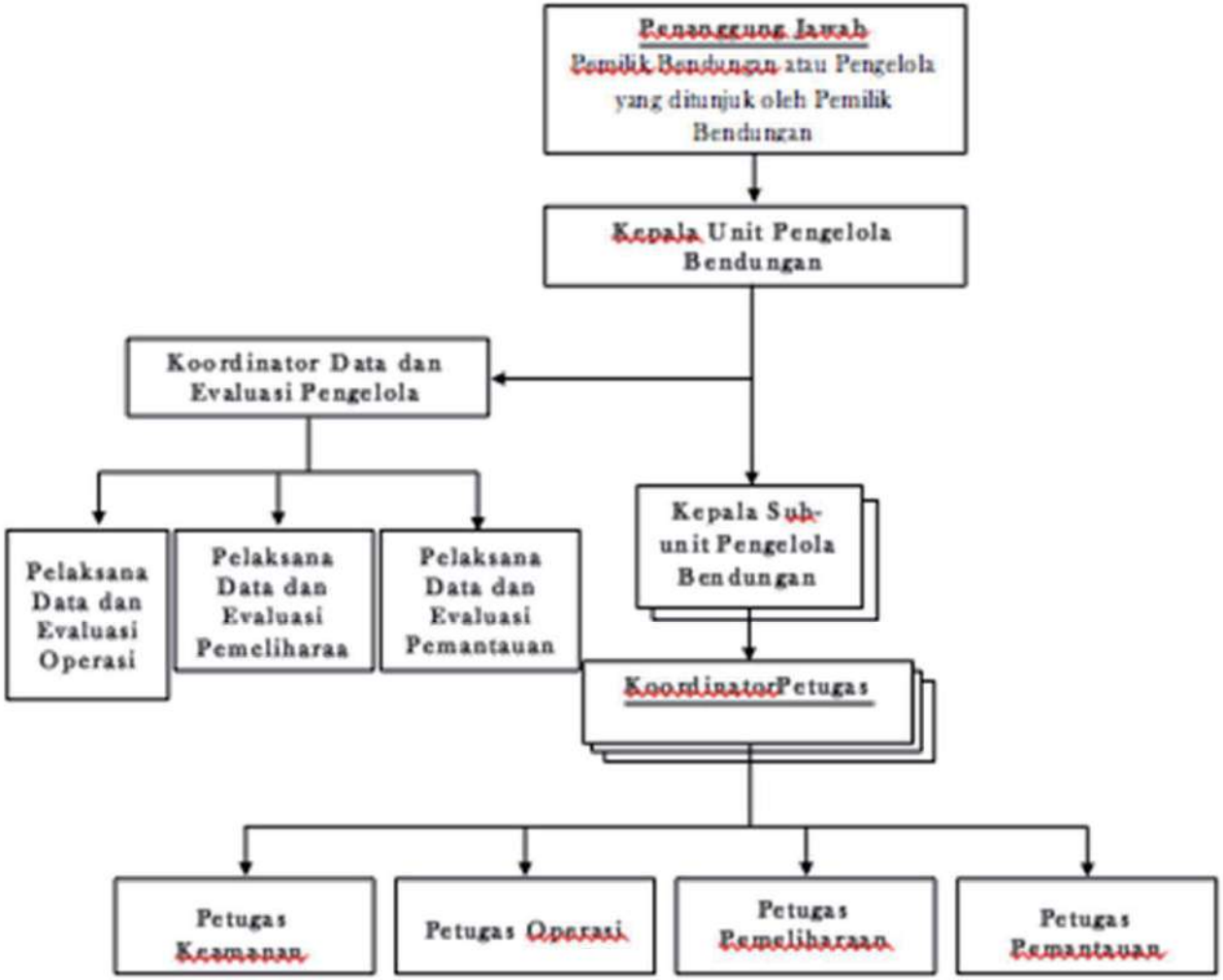
MELAKSANAKAN PENGELOLAAN BENDUNGAN BESERTA WADUKNYA MELIPUTI

1. MENYUSUN RENSTRA OP UNTUK 5 TAHUNANGGARAN (PEMERIKSAAN DAN OPP RUTIN, PEMERIKSAAN DAN OPP BERKALA, INSPEKSI BESAR, SPECIAL STUDY)
2. MENYUSUN CANOP SETIAP TAHUN ANGGARAN (DETAIL DARI RENSTRA)
3. MENYUSUN ROTW
4. MELAKSANAKAN OPERASI, PEMELIHARAAN, DAN PEMANTAUAN (OPP) SERTA PENGAMANAN
5. PEMUTAKHIRAN RTD (5 TH)
6. PEMUTAKHIRAN PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (5 TH)
7. PEMUTAKHIRAN POLA OPERASI WADUK (5 TH)
8. MENYUSUN SOP UNTUK UPB DAN PETUGAS OPP

DOKUMEN YANG HARUS DIMILIKI OLEH UPB

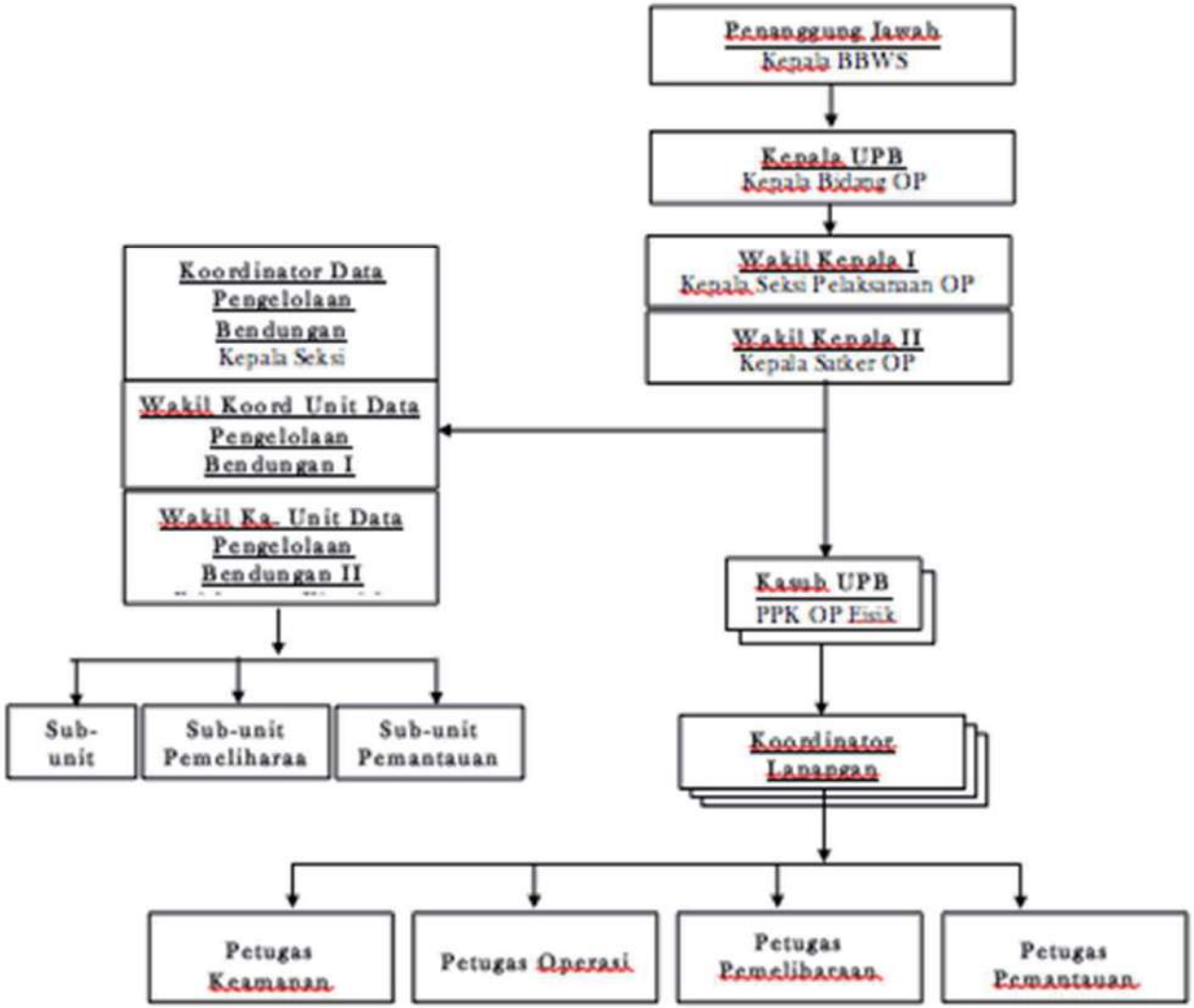
1. IZIN PENGGUNAAN SDA (Ps 10)
2. PERSETUJUAN PRINSIP PEMBANGUNAN BENDUNGAN (Ps 16) 5 TH, 1X
3. PERSETUJUAN DESAIN BENDUNGAN (Ps 24) **
4. DOKUMEN STUDI PENGADAAN TANAH DAN STUDI PEMUKIMAN KEMBALI (Ps 26)
5. IZIN PELAKSANAAN KONSTRUKSI BENDUNGAN (Ps 30) ** UNTUK 3 TH
6. RENCANA PENGELOLAAN BENDUNGAN YANG BERISIKAN
7. PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (TERMASUK AKNOP) DILENGKAPI DENGAN
8. POLA OPERASI WADUK (5 TH) (Ps 45, 46, 47)
9. RENCANA TINDAK DARURAT/ RTD (Ps 53)
10. IZIN PENGISIAN AWAL WADUK (Ps 64) **
11. AS BUILT DRAWING
12. DOKUMEN LAPORAN AKHIR PELAKSANAAN KONSTRUKSI (PS 90) **
13. IZIN OPERASI (PS 92) **
14. PENETAPAN STATUS PENGGUNAAN (PSP) >>> **BMN / ASET**

BENTUK UMUM ORGANISASI UNIT PENGELOLA BENDUNGAN



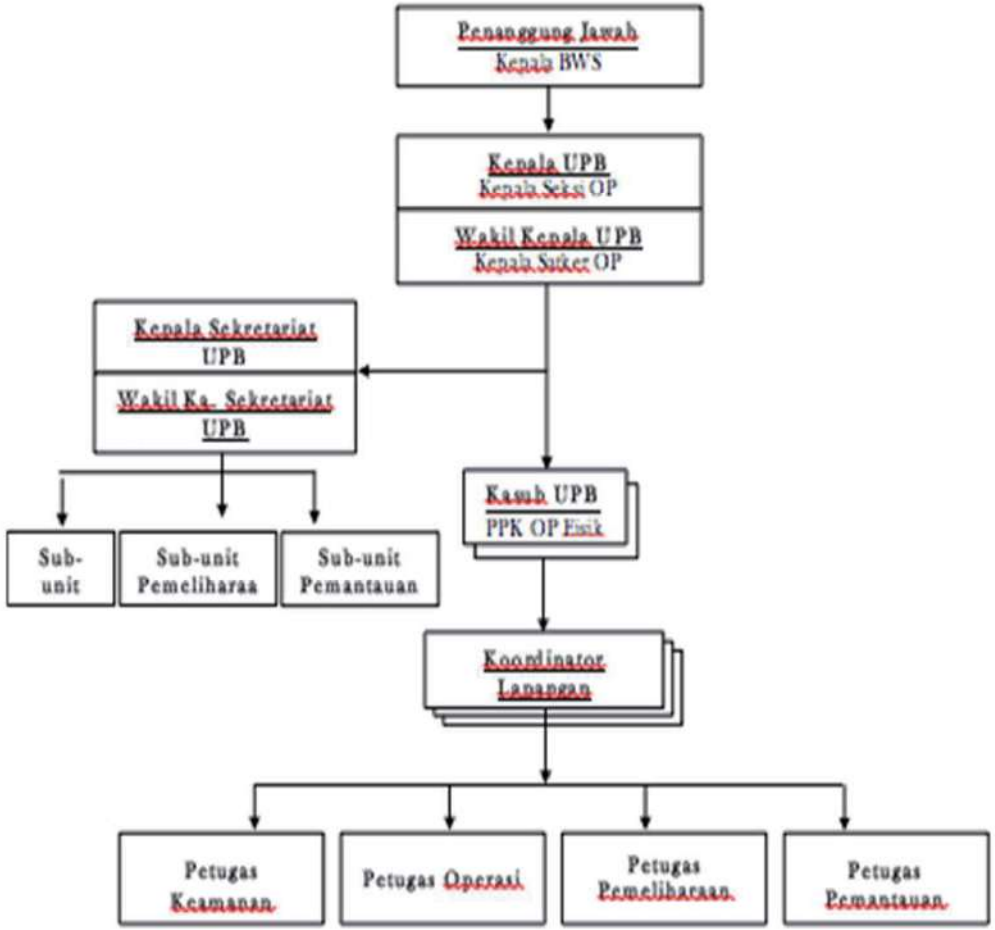
A6-3-No.004-203

BENTUK ORGANISASI UNIT PENGELOLA BENDUNGAN PADA BALAI BESAR WILAYAH SUNGAI (BBWS) TIPE A DAN TIPE B

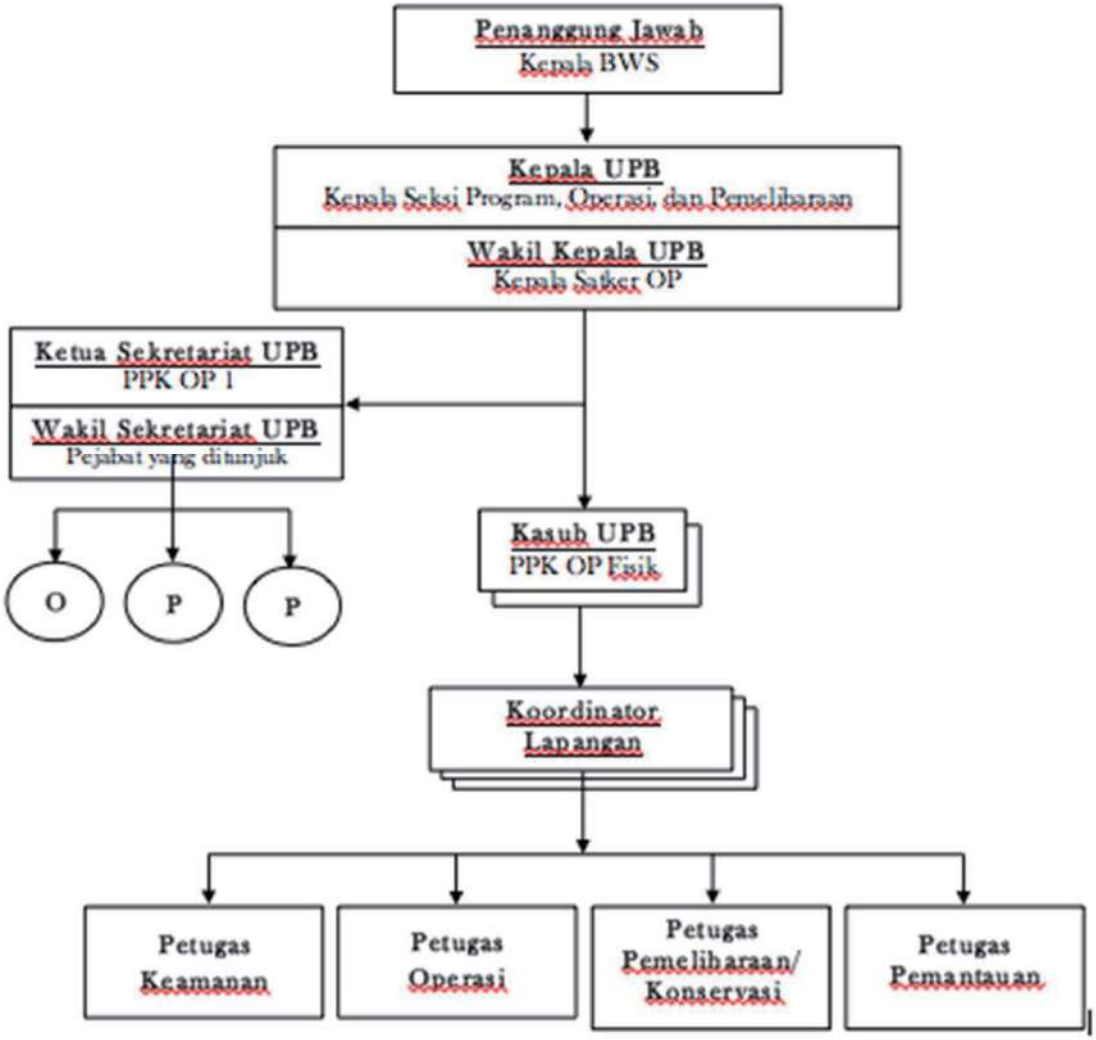


A6-3-No.004-204

BENTUK ORGANISASI UNIT PENGELOLA BENDUNGAN PADA BALAI WILAYAH SUNGAI (BWS) TIPE A



c. TIPOLOGI ORGANISASI BWS Tipe B



A6-3-No.004-206

PERSIAPAN OPERASI AN PEMELIHARAAN (POP)

PERSIAPAN OPERASI PEMELIHARAAN (POP)

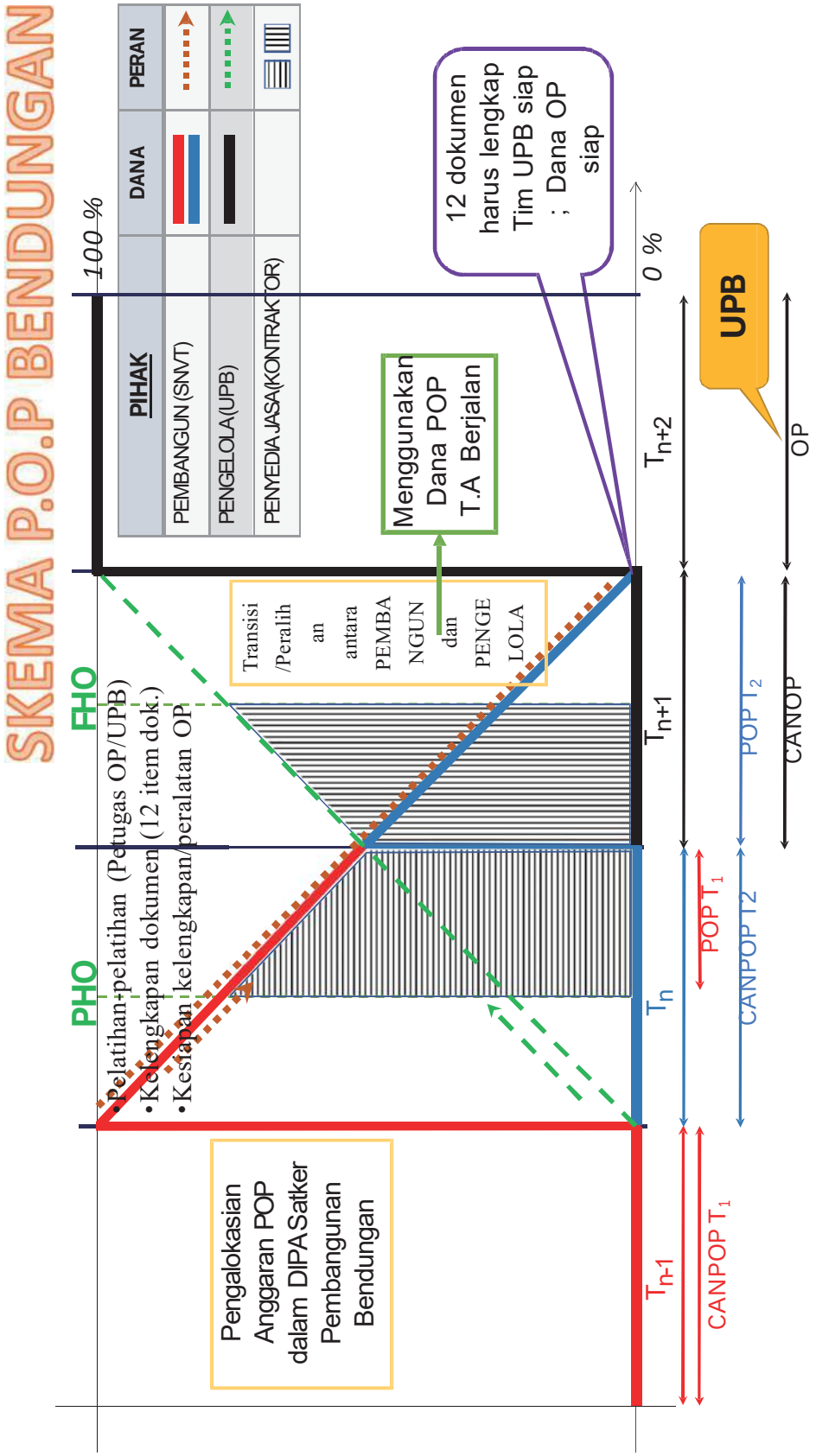
- POP ADALAH MASA TRANSISI DARI PEMBANGUNAN KE PENGELOLAAN
- DIPERLUKAN ORGANISASI POP YANG DITETAPKAN OLEH KEPALA BALAI DIDALAMNYA ADA UNSUR PEMBANGUN DAN ADA UNSUR PENGELOLA / UPB
- DALAM MASA TRANSISI INI DISERAHKAN DATA DAN TEKNOLOGI SERTA SARPRAS OP DARI UNIT PEMBANGUN KEPADA UNIT PENGELOLA

PERSIAPAN OPERASI PEMELIHARAAN (POP)

- ORGANISASI POP MEMBUAT PERENCANAAN POP (CANPOP) UNTUK MASA PALING LAMA 2 TAHUN ANGGARAN
- ANGGARAN DIPROGRAMKAN PADA UNIT PEMBANGUN UNTUK SETIAP TAHUN ANGGARAN
- MELAKSANAKAN POP TERINTEGRASI DENGAN KEGIATAN MASA PEMELIHARAAN KONSTRUKSI
- SELESAI MASA POP UNIT PENGELOLA SIAP UNTUK MENGELOLA

DOKUMEN YANG HARUS DISIAPKAN OLEH PEMBANGUN YANG HARUS DISERAHKAN KEPADA UPB PADA MASA POP

1. IZIN PENGGUNAAN SDA (Ps 10)
2. PERSETUJUAN PRINSIP PEMBANGUNAN BENDUNGAN (Ps 16) 5 TH, 1X
3. PERSETUJUAN DESAIN BENDUNGAN (Ps 24) **
4. DOKUMEN STUDI PENGADAAN TANAH DAN STUDI PEMUKIMAN KEMBALI (Ps 26)
5. IZIN PELAKSANAAN KONSTRUKSI BENDUNGAN (Ps 30) ** UNTUK 3 TH
6. RENCANA PENGELOLAAN BENDUNGAN YANG BERISIKAN
7. PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (TERMASUK AKNOP) DILENGKAPI DENGAN
8. POLA OPERASI WADUK (5 TH) (Ps 45, 46, 47)
9. RENCANA TINDAK DARURAT/ RTD (Ps 53)
10. IZIN PENGISIAN AWAL WADUK (Ps 64) **
11. AS BUILT DRAWING
12. DOKUMEN LAPORAN AKHIR PELAKSANAAN KONSTRUKSI (PS 90) **
13. IZIN OPERASI (PS 92) **
14. PENETAPAN STATUS PENGGUNAAN (PSP) >>> **BMN / ASET**


SKEMA P.O.P BENDUNGAN
PIHAK
DANA
PERAN
PEMBANGUN (SNVT)
PENGELOLA(UPB)
PENYEDIA JASA(KONTRAKTOR)
100 %
0 %
PHO
FHO
•Pelatihan-pelatihan (Petugas OP/UPB)
•Kelengkapan dokumen (12 item dok.)
•Kesiapan kelengkapan/peralatan OP
Transisi /Peralihan antara PEMBANGUN dan PENGELOLA
Menggunakan Dana POP T.A Berjalan
12 dokumen harus lengkap Tim UPB siap ; Dana OP siap
UPB
Pengalokasian Anggaran POP dalam DIPA Satker Pembangunan Bendungan
T_{n-1}
T_n
T_{n+1}
T_{n+2}
CANPOP T_1
POP T_1
CANPOP T_2
POP T_2
CANOP
OP

A6-3-No.004-212

KEMENTRIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
PUSAT BENDUNGAN
Jl. Patimura No. 20 Telp. 27515389, Fax. 27515389 Kebayoran Baru – Jakarta Selatan 12110

Jakarta, 02 April 2018

No : PR.03-04-A3/136
Lampiran :
Hal : Persiapan Operasi dan Pemeliharaan Bendungan

Kepada Yth
(Daftar terlampir)

Dengan Hormat,
Sehubungan dengan Nota Dinas dari Direktur Bina Operasi dan Pemeliharaan Nomor: 20/No/AR/III/2018 tentang Persiapan Operasi dan Pemeliharaan Bendungan, maka bersama ini kami sampaikan kepada Kepala BBWS/ BWS (terlampir) untuk dapat mempersiapkan hal – hal sebagai berikut:

1. Persiapan Operasi dan Pemeliharaan adalah masa transisi dari pembangunan ke pengelolaan, dimana untuk persiapan tersebut diperlukan suatu organisasi dapat berupa Tim atau Panitia yang ditetapkan oleh Kepala BBWS/ BWS dan didalamnya terdapat unsur dari pembangunan dan unsur dari pengelola.
2. Dalam masa transisi tersebut diserahkan data dan teknologi serta sarana dan prasarana Operasi dan Pemeliharaan dari unit pembangunan kepada unit pengelola, dimana sesuai Permen PUPR No. 27 Tahun 2015 tentang Bendungan bahwa dokumen yang harus diserahkan yaitu:
   a. Izin Penggunaan Sumber Daya Air (Ps.10)
   b. Persetujuan Prinsip Pembangunan Bendungan (Ps. 16)
   c. Persetujuan Desain Bendungan (Ps.24)
   d. Dokumen Studi Pengadaan Tanah dan Studi Permukiman kembali (Ps.26)
   e. Izin Pelaksanaan Konstruksi Bendungan (Ps.30)
   f. Rencana Pengelolaan Bendungan
   g. Pedoman Operasi dan Pemeliharaan Bendungan beserta Waduknya
   h. Pola Operasi Waduk (Ps 45, 46, 47)
   i. Rencana Tindak Darurat (RTD) (Ps.53)
   j. Izin Pengisian Awal Waduk (Ps.64)
   k. As Build Drawing
   l. Izin Operasi (Ps.92)
   m. Penetapan Status Penggunaan (PSP)
3. Organisasi Persiapan Operasi dan Pemeliharaan yang dibentuk tersebut agar membuat Perencanaan O&P untuk masa paling lama 2 tahun anggaran, dimana pelaksanaannya dapat terintegrasi dengan kegiatan masa pemeliharaan konstruksi dan penganggarannya diprogramkan pada unit pembangunan sebagaimana skema terlampir.
4. Pengelola bendungan dalam melaksanakan pengelolaan bendungan beserta waduknya dibantu oleh Unit Pengelola Bendungan (UPB), dimana setiap Balai sebagai Pengelola bendungan wajib membentuk Unit Pengelola Bendungan yang ditetapkan oleh Pemilik atau Pengelola Bendungan, sehingga dengan demikian setiap Unit Pengelola Bendungan siap untuk mengelola saat selesai masa Persiapan Operasi dan Pemeliharaan.

Demikian kami sampaikan, atas perhatiannya diucapkan terima kasih.

Kepala Pusat Bendungan

Dr. Ir. Ni Made Sumiarsih, M.Eng
NIP. 19600225 198603 2 005

Tembusan Kepada Yth:

1. Direktur Jenderal Sumber Daya Air (Sebagai Laporan)
2. Direktur Bina Operasi dan Pemeliharaan Ditjen SDA
3. Direktur Pengembangan Jaringan Sumber Daya Air Ditjen SDA
4. Arsip

Lampiran :
Daftar Lampiran

1. Kepala Balai Balai Besar Wilayah Sungai Brantas
2. Kepala Balai Balai Besar Wilayah Sungai Cimanuk Cisanggarung
3. Kepala Balai Balai Besar Wilayah Sungai Bengawan Solo
4. Kepala Balai Balai Besar Wilayah Sungai Pemali Juana
5. Kepala Balai Balai Besar Wilayah Sungai Cidanau Ciujung Cidurian
6. Kepala Balai Balai Besar Wilayah Sungai Ciliwung Cisadane
7. Kepala Balai Balai Besar Wilayah Sungai Mesuji Sekampung
8. Kepala Balai Balai Besar Wilayah Sungai Citanduy
9. Kepala Balai Balai Besar Wilayah Sungai Pompengan Janeberang
10. Kepala Balai Balai Wilayah Sungai Sumatera I
11. Kepala Balai Balai Wilayah Sungai Sumatera II
12. Kepala Balai Balai Wilayah Sungai Sumatera IV
13. Kepala Balai Balai Wilayah Sungai Bali Penida
14. Kepala Balai Balai Wilayah Sungai Kalimantan III
15. Kepala Balai Balai Wilayah Sungai Nusa Tenggara I
16. Kepala Balai Balai Wilayah Sungai Nusa Tenggara II
17. Kepala Balai Balai Wilayah Sungai Kalimantan II
18. Kepala Balai Balai Wilayah Sungai Sulawesi I
19. Kepala Balai Balai Wilayah Sungai Sulawesi IV
20. Kepala Balai Balai Wilayah Sungai Maluku

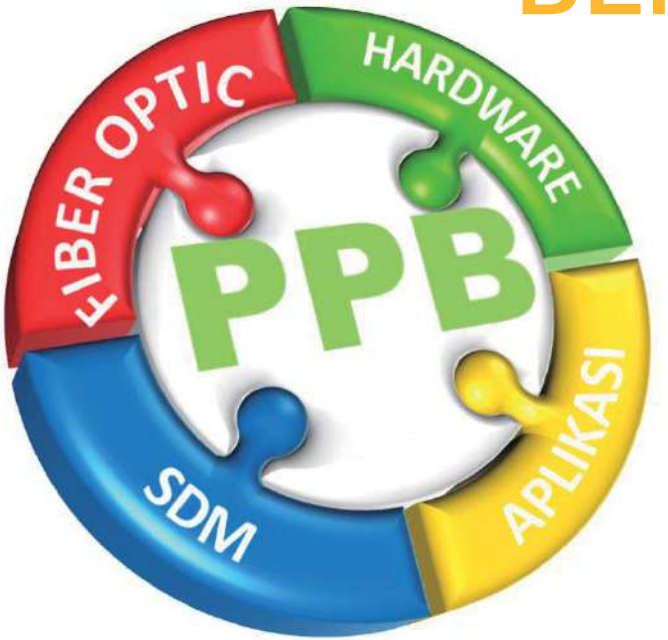
APLIKASI PEMANTAUAN BENDUNGAN

A6-3-No.004-213

APLIKASI PEMANTAUAN BENDUNGAN

- Diperlukan aplikasi dalam rangka mendukung pengeloaan bendungan agar lebih efisien.
- Real time monitoring untuk kondisi bendungan di seluruh Indonesia baik dari sisi layanan (irigasi, air baku, pengendalian banjir, energi) maupun status keamanan (hidraulis, struktur dan rembesan)
- Status tersebut tersajikan dalam bentuk peta maupun data tabular
- Memiliki data historis baik berupa prediksi inflow, realisasi inflow, status layanan irigasi, air baku, pengendalian banjir, energi yang diperoleh, status keamanan bendungan.
- Data management untuk evaluasi rencana operasi waduk dalam rangka kesiap siagaan banjir dan kekeringan
- Evaluasi terkait rencana pembangunan infrastuktur terkait besarnya efisiensi irigasi maupun cakupan layanan akses air bersih
- Tersedianya forum dalam rangka diskusi masing-masing pengelola UPB dengan direktorat Pembina maupun PUSAIR dan Balai bendungan terkait permasalahan yang dihadapi dalam pengeolaan bendungan
- Tersedianya data centre untuk menyimpan soft file dokumen bendungan

KOMPONEN PEMANTAUAN BENDUNGAN



Pusat Pemantauan Bendungan terdiri dari 4 komponen yaitu :

- ***APLIKASI***. Dibutuhkan sistem aplikasi yang terintegrasi dengan bidang lain (irigasi, air baku, sisda, hidrologi, pusdatin, pusben, PWS, Balai Bendungan,PUSAIR, PJT1, PJT2, Indonesia Power, PIJB, dan balai) dalam rangka untuk pengelolaan bendungan dalam mendukung ketahanan pangan dan ketahanan air.
- ***FIBER OPTIC***. Jaringan fiber optic dipergunakan sebagai sarana lalu lintas data untuk mendukung **stabilitas** jaringan. Layanan yang dipilih adalah fiber optic dgn ***intranet dedicated*** dgn konsep ***IPVPN*** untuk **keamanan** jaringan.
- ***HARDWARE***. Dibutuhkan komponen hardware untuk menjalankan aplikasi baik di tingkat pusat (server) maupun di lingkungan UPB balai. Perhitungan kebutuhan hardware menyesuaikan beban kerja dari aplikasi yang akan dijalankan.
- ***SDM***. Diperlukan SDM yang memadai untuk dapat menjalankan aplikasi. Peningkatan kemampuan SDM mutlak dilakukan yaitu dengan menambah kemampuan dalam perhitungan proyeksi ketersediaan air, pola operasi waduk dan perhitungan keamanan.

Thank You

Bekerja Keras – Bergerak Cepat – Bertindak Tepat
BERANI – KUAT – BERJIWA SENI

ANNEX 6-3

Seminar No.005

Technical Information Sharing Seminar on Sediment Management of Dam Reservoir at BWS Sulawesi I

Technical Information Sharing Seminar on

Sediment Management of Dam Reservoir at BWS Sulawesi I

Date: 10:00 – 16:30, 15th August (Wednesday)

Venue: Meeting Room in Novotel Hotel Manado

Chair Person: Mr. Fauzi Idris, Director of Water Resources Management

Participants: RBO Project Team at BWS Sulawesi I

Sub-dit of O/M Dam and Lakes, Directorate of O/M, Directorate General of SDA

Sakter Bendungan (Kuwil Dam and Lolak Dam) at BWS Sulawesi 1

Staff from B(B)WSs that have dam proejcts

Consultants and Contractors for Kuwil Dam and Lolak Dam Construction Project

Time	Contents	Presenter
10:00 - 10:15	Opening Remarks	Mr. Fauzi Idris, Director of Water Resources Management
10:15 - 10:30	Opening Remarks	Mr. Djidon R. Watania, Head of BWS Sulawesi I
Session 1: Sediment Management for Dam Reservoir		
10:30 - 11:30	New Guideline of Sediment Management for Dam Reservoir	Mr. MIURA Hirohisa Technical Expert of JICA Project
11:30 - 12:00	Upper-watershed Management as part of O&M of Dam & Reservoir	Mr. Sarwono, JICA Project
Lunch		
Session 2: Countermasures for Sedimentation at Dam Reservoir		
13:30 - 14:30	Sediment Management for Dam in Indonesia	Mr. M. Adek Rizaldi, Head of Subdit OP Dam & Lake
14:30 - 15:30	Countermeasures for Sedimentation at Miwa Dam and others in Japan	Mr. MIURA Hirohisa Technical Expert of JICA Project (Mr. Rian, Manager Sakter OP, BBWS Ciliwung Cisadane: Participant of Training in Japan 2018)
Coffee Break		
Session 3: Discussion on OJT Activity		
15:45 - 16:15	Question & Answer	Mr. MIURA Hirohisa Technical Expert of JICA Project, Mr. M. Adek Rizaldi, Head of Subdit OP Dam & Lake
16:15 - 16:25	Discussion and Decision; -Good Example and References for Operation & Maintenance Planning of Kuwil Dam and others -Confirmation of Schedule of Kuwil dam operation & maintenance planning	
16:25 - 16:30	Closing Remarks	Mr. Djidon R. Watania, Head of BWS Sulawesi I

New Guideline on Sediment Management at Dam Reservoir in Japan

MIURA HIROHISA, JICA Expert,
The project on Capacity Development for RBOs in Integrated Water Resources management in Indonesia (Phase 2)

Tokuyama Dam (Rock-fill)

Kin Dam (Trapezoid-shaped CSG)

Kawaji Dam (Concrete Arch)

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Ministry of Land, Infrastructure, Transport and Tourism

1. Status of Dam Operation and Maintenance in Japan

Transition of Number of Dam managed by MLIT

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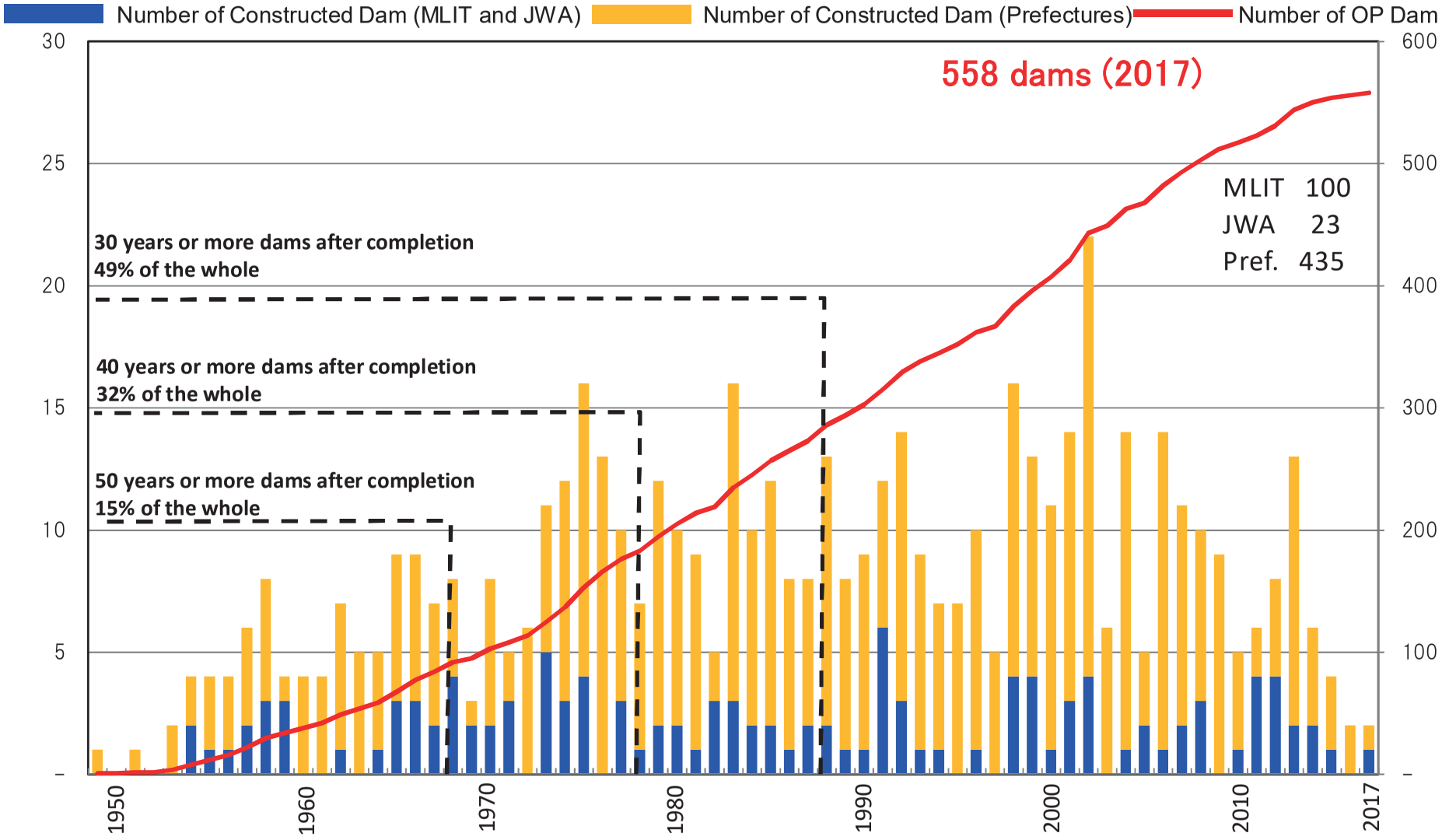
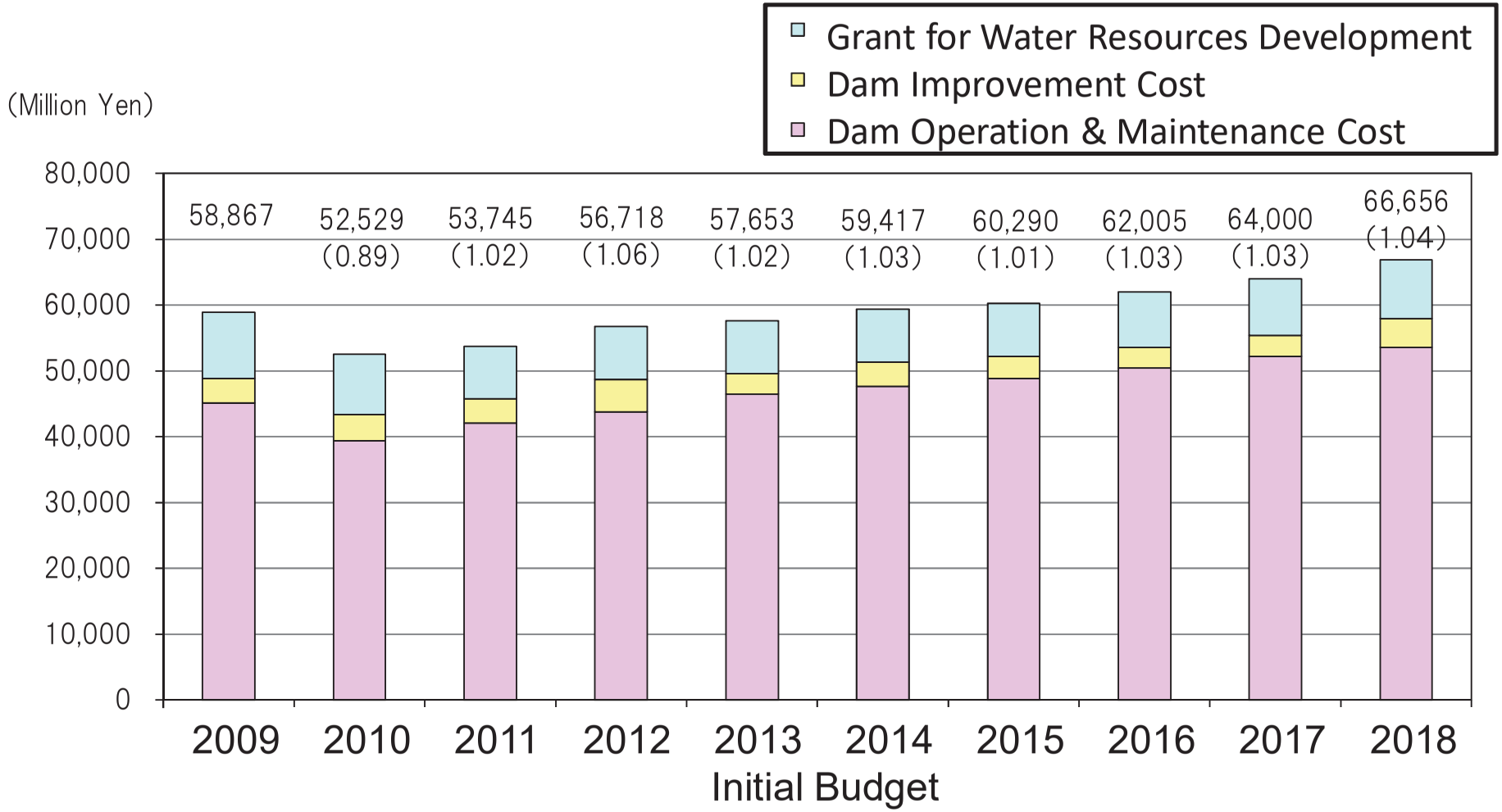
●558 dams are managed by MLIT, Japan Water Agency (JWA) and Prefectures in Japan (2017)



A6-3-No.005-7

Transition of Dam O/M Budget（MLIT and JWA）

国土交通省

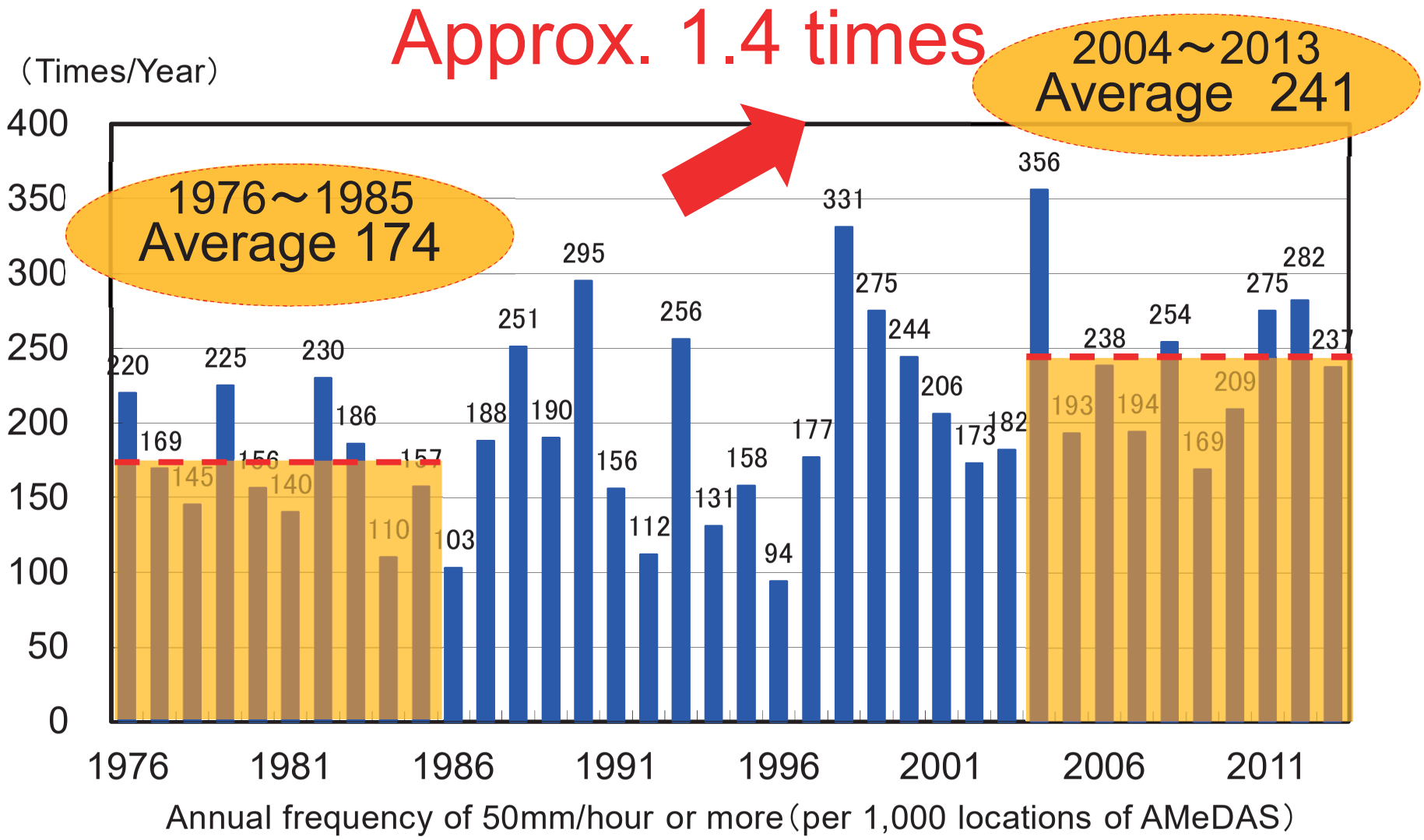


A6-3-No.005-8

Situation of Rainfall in recent years in Japan

国土交通省

●Increases frequency of short time heavy rain that over 50mm/hour (about 1.4 times of 30 years ago)



Sources: Japan Meteorological Agency

A6-3-No.005-9

Issues on Dam O/M

① Latest Technical Standard

② MLIT's Vision to Upgrade Dams under Operation

③ Countermeasures for Sedimentation

④ Promoting installment of Micro-Hydropower

⑤ Applying new technology for O/M

Latest Standards for O/M

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Standards that MLIT Japan formulated for O/M	Date
Manual on Dam Comprehensive Inspection	Oct. 2013
Technical Criteria on River Works, Chapter of O/M [Dam part]	April 2014
Manual of Water Quality monitoring at Dam Reservoir	March 2015
Guideline on middle-scale Flushing Discharge（Draft）	May 2015
Guideline on Periodical Inspection of Dam	March 2016
MLIT's Vision to Upgrade Dams under Operation	June 2017
Manual and Descriptions on Checking Dam Operation Rules to Improve Flood Control Method to Maximize Dam Functions and Effects	July 2017
Guideline on Sediment Management at Dam Reservoir (Draft)	March 2018
Guideline on Countermeasure for Drift wood at Dam Reservoir (Draft)	March 2018
Guideline on Water Quality Improvement at Dam Reservoir (Draft)	March 2018
Manual on Robot Utilization for Facility Maintenance in the Water (Draft) [Dam Body]	May 2018 (Planned)
Manual on Robot Utilization for Facility Maintenance in the Water (Draft) [Outlet Works]	May 2018 (Planned)

2. Sediment Management for Dam Reservoir

- New Guideline on Sediment Management at Dam Reservoir (Draft) -

Basic Policy on Countermeasures for Dam Sedimentation

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- Basically, Capacity of Sedimentation is considered a volume that will be stored for 100 years. Capacity for Flood Control is included 20% margin/flexible capacity by consideration of sedimentation
- Sedimentation is usually planned to remove from reservoir

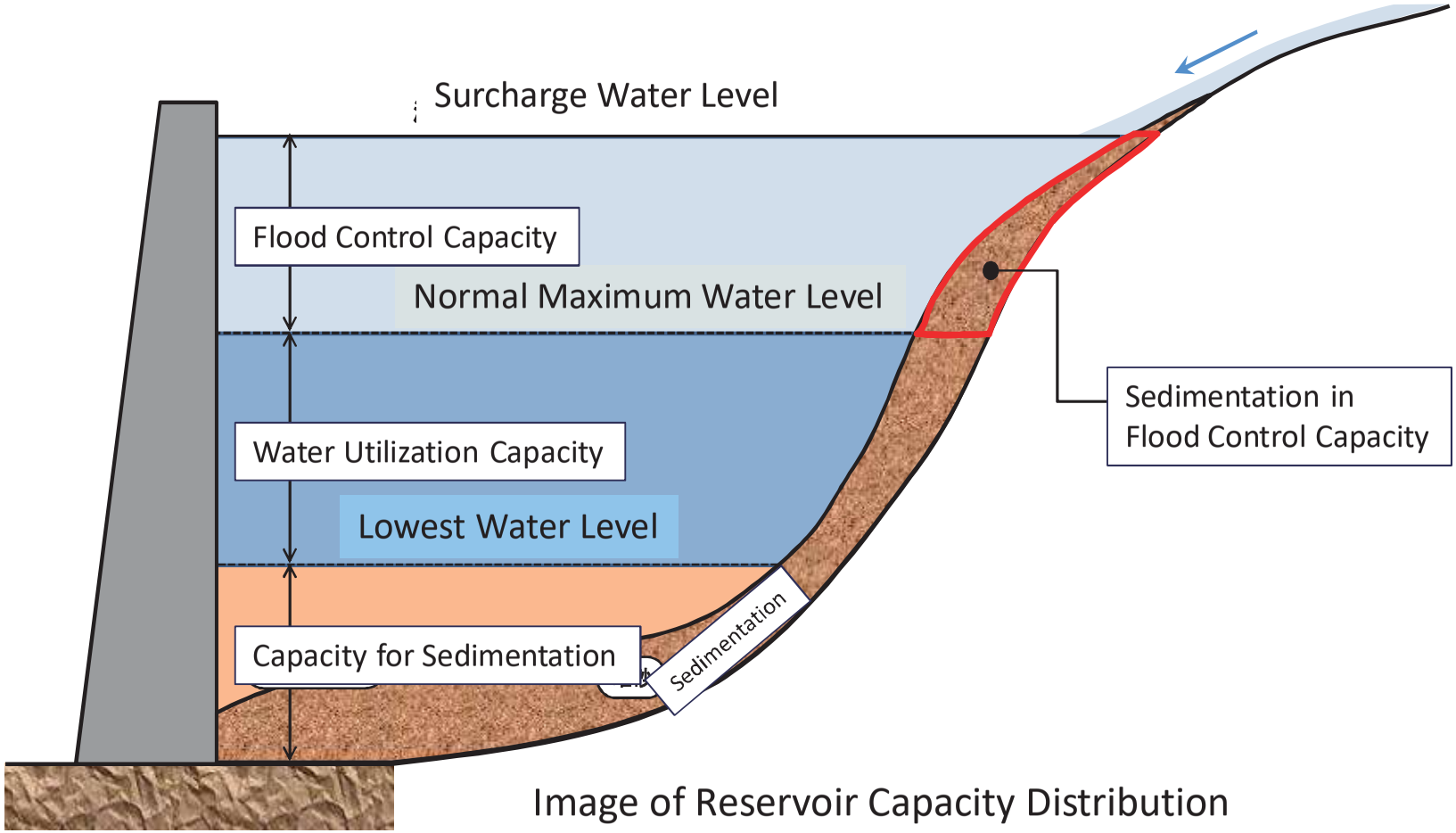

Image of Reservoir Capacity Distribution

A6-3-No.005-13

Sedimentation Situation of MLIT's Dams

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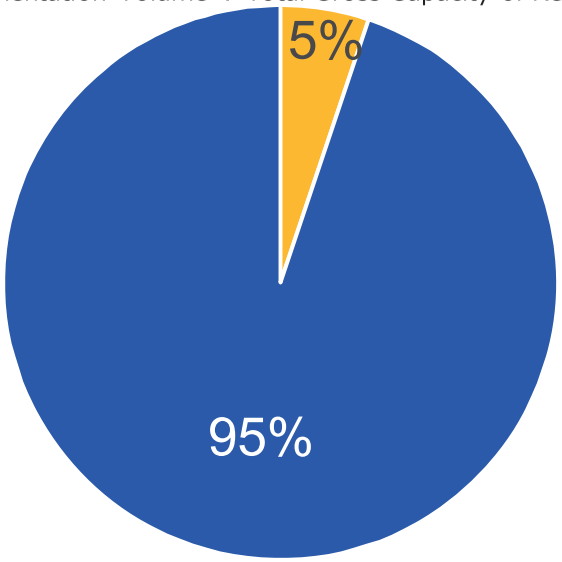
Sedimentation Situation of MLIT's Dams
(March, 2017)

- Total rate of sedimentation in all dams of MLIT is approx. 5% against gross capacity of reservoirs
- There are some dams that sedimentation overs planned sedimentation and sediment occupies flexibility of flood control capacity. However all of dam conducts or considers countermeasures

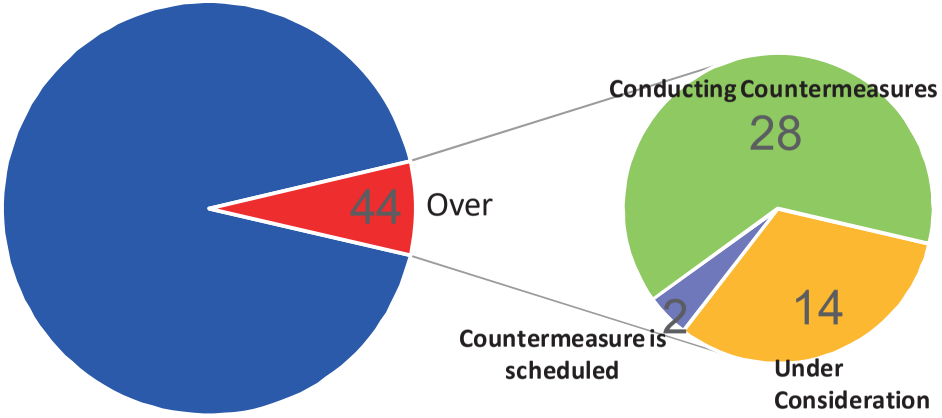
◆Sedimentation rate of Gross Capacity of Reservoirs

Sedimentation Rate against Gross Capacity of Reservoirs of MLIT, Province and JWA
(Total Sedimentation Volume ÷ Total Gross Capacity of Reservoirs)



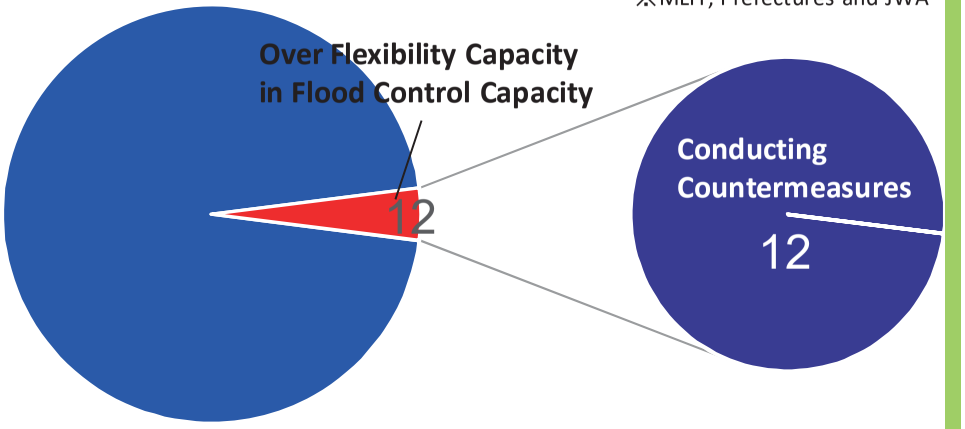
◆Against Planned Sedimentation Volume (558 Dams)

Number of Dam that overs planned Volume ※MLIT, Province and JWA



◆Sedimentation in Flood Control Capacity (558 Dams)

※MLIT, Prefectures and JWA



※Sedimentation data: as of March 2017, Conducting Countermeasures Information: as of July 2018

New Guideline on Sediment Management at Dam Reservoir

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Table of Contents of Guideline on Sediment Management at Dam Reservoir

1. **Introduction**
   - 1.1 Purpose
   - 1.2 Scope of Application
   - 1.3Orientation
   - 1.4 Definitions
2. **Survey and Observation for Sediment Management at Dam Reservoir**
   - 2.1 Preliminary Survey
   - 2.2 Detail Inspection
3. **Criteria of Countermeasure Implementation**
   - 3.1 Research on Progress of Sedimentation
   - 3.2 Criteria of Countermeasures Implementation
   - 3.3 Calculation on Requirement Volume of Sediment Removal
4. **Organizing and Accumulating Data**

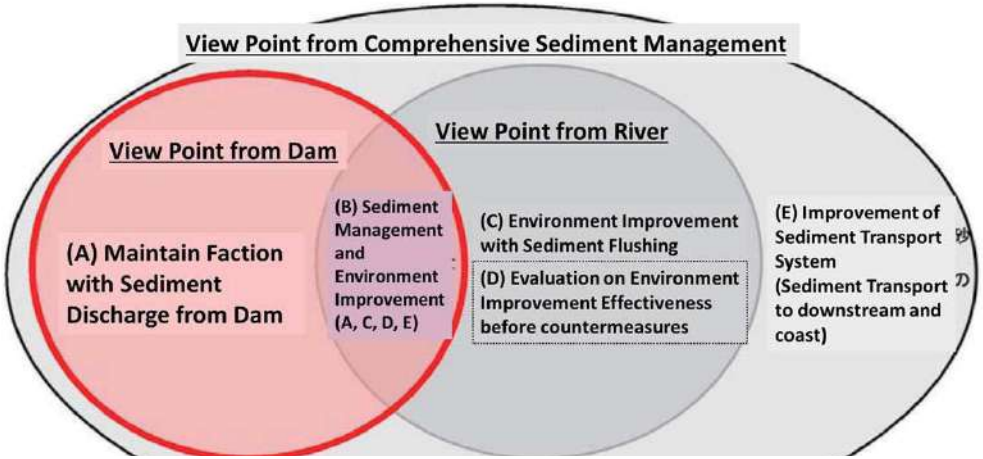
<<Appendix>>

I. Application of Asset-Management to Sediment Management

II. Survey and Observation Method

III. Details of Indication of Evaluation

IV. Research for Adequate Countermeasure of Sedimentation

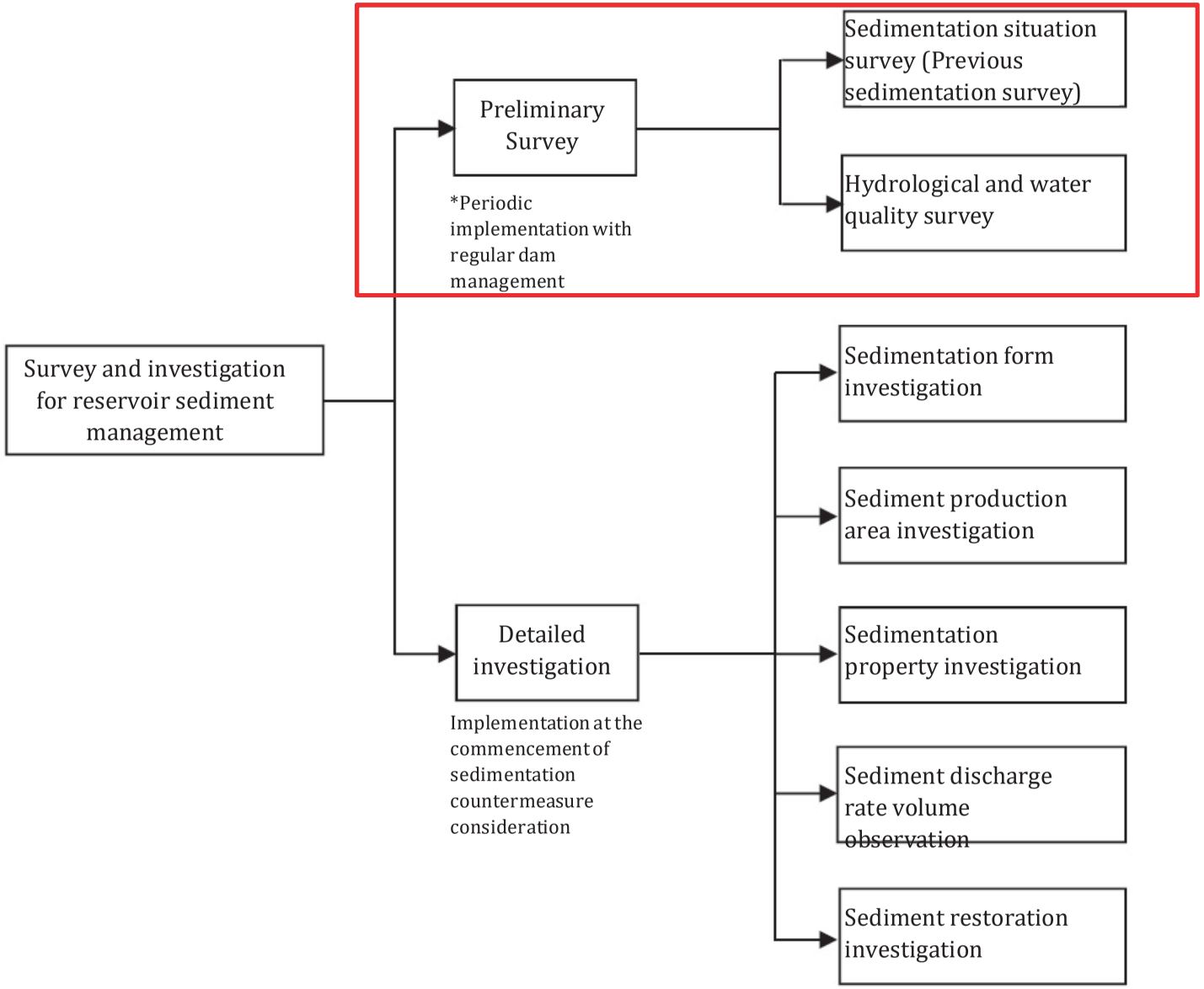


Purpose of Countermeasure for Sedimentation
(Red line frame shows scope of application of the guideline)

New Guideline on Sediment Management at Dam Reservoir

国土交通省

2. Survey and Observation for Sediment Management for Dam Reservoir



New Guideline on Sediment Management at Dam Reservoir

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2. Survey and Observation for Sediment Management for Dam Reservoir

Classification		Survey purpose	Survey item	Survey area	Survey method	Survey frequency	Remarks
Preliminary Survey	Sedimentation situation survey	Understanding of sedimentation characteristics	Sedimentation situation	Reservoir	Cross-sectional survey Aerial laser survey Bathymetric survey Laser measurement	Basically once a year	Procedure for survey of sedimentation situation of dam (draft), Technical Criteria for River Works, Investigation compilation
	Hydrological and water quality survey	Understanding of hydrological and water quality characteristics	Rainfall volume	Dam basin	Telemeter Radar rainfall volume	Hourly	River law, Technical Criteria for River Works, Investigation compilation
			Reservoir level, inflow / discharge volume	Reservoir	Telemeter	Hourly	Same as above
			Water quality (turbidity)	Reservoir, River linked with dam	Water sampling / analysis (Automatic investigation)	Once a month (In principle, automatic observation should be performed at least once a day)	Conformity to "Dam Reservoir Water Quality Survey Procedure"

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< Reference >

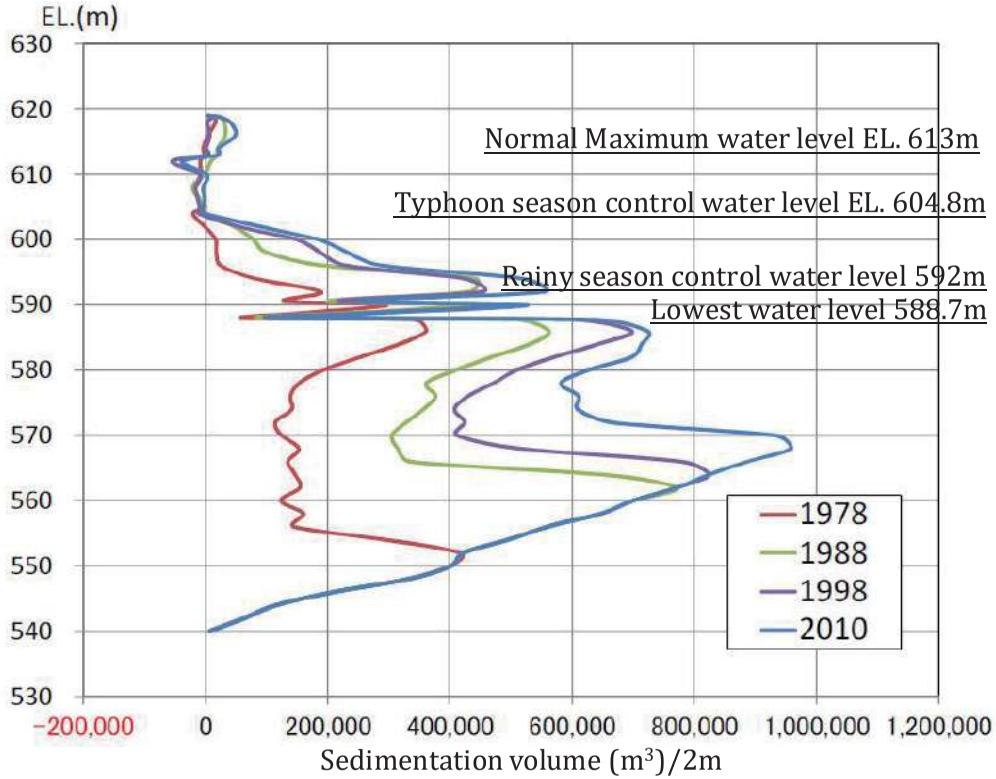
Utilization example of sedimentation survey data ①(Relationship between reservoir operation and sedimentation progression)

With regard to data acquired by sedimentation survey, by arranging the sedimentation survey from the past, it becomes possible to grasp the tendency of sedimentation etc.

Figure shows the changes in sedimentation volume and water storage capacity for every altitude of the Koshibu Dam in the Chubu region for every 10 years. According to this, the relation between reservoir operation and sedimentation progression can be easily understood.

Source) Tetsuya Haku, "Selection of Dam Sedimentation Database and Suitable Reservoir Sediment Management Measures in Japan", ICOLD 2013 International Symposium.

At the Koshibu Dam, the reservoir level is reduced to EL.592m and EL.604.8m respectively, in preparation for flood reservoir during the rainy season (June - July) and typhoon season (August - September). Due to these periodic lowering of the reservoir level, the temporarily accumulated sediment at the upstream end of the reservoir is further effectively transported to the deep part of the reservoir.



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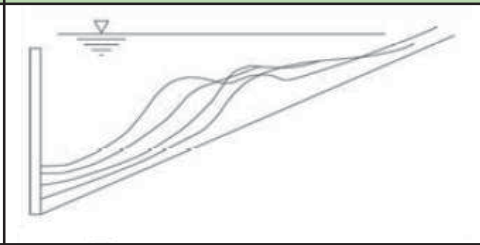
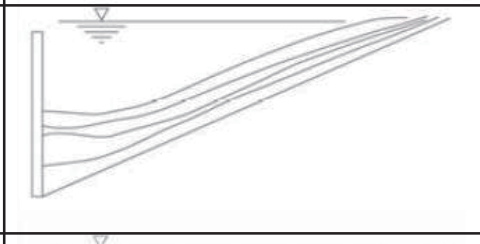
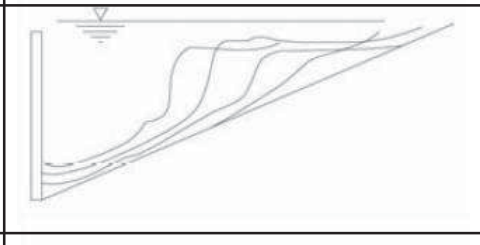
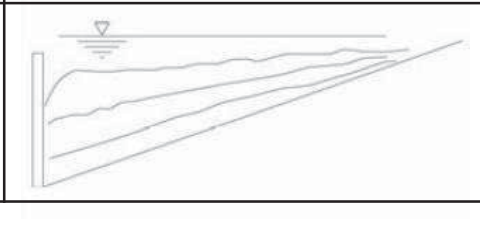
Utilization example of sedimentation survey data ② (basic classification of sedimentation form)

The sedimentation form of the reservoir is classified into the basic type as shown in the table below from the investigation results of the sedimentation form in various parts of Japan.

Table: Basic classification of sedimentation form

Source) "Construction of multi-purpose dam - 2005 edition" Compilation & Issue / Dam Technology Center Foundation

Basic classification	Sedimentation form	Characteristic
Type I		-Both bed load sand and suspended sand are seen when considerable volume flowing in. -There are considerable collapsed areas in the basin and it is seen where sediment production is active. -The delta shoulder is usually seen near the full water level. (however, the position of the delta shoulder varies depending on the operation of each dam)
Type II		-Most of the inflowing sediment is formed in the case of fine suspended sand. -There are many cases when there is a large-scale reservoir immediately upstream or there is a gentle slope section upstream of the reservoir and there is little inflow of bed load sand.
Type III		-It is a form where the supply source of suspended sand is small and it appears in a relatively early stage of sedimentation.
Type IV		-It is a form seen when sediment is remarkably accumulated near the dam with a small-scale reservoir.

New Guideline on Sediment Management at Dam Reservoir

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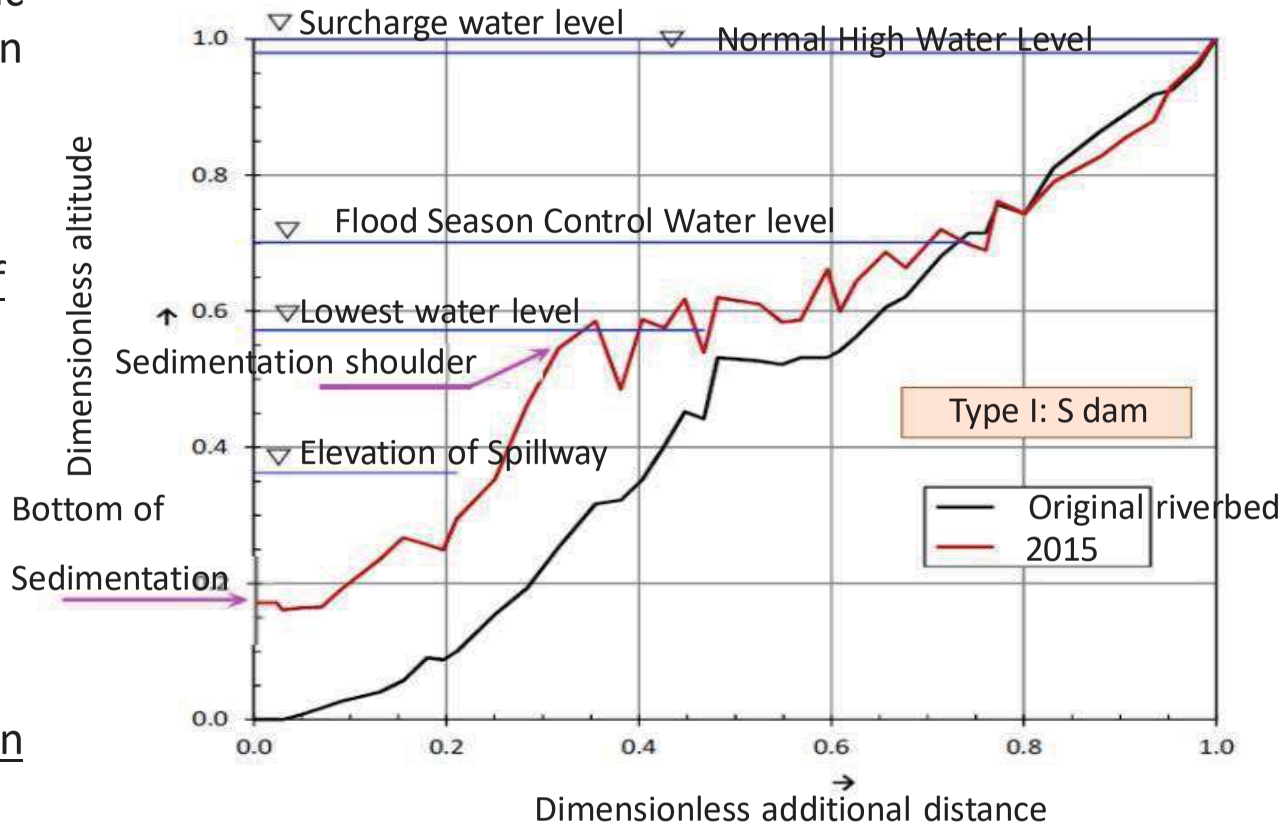
Utilization example of sedimentation survey data ② (basic classification of sedimentation form)

The sedimentation form of the reservoir is classified into the basic type as shown in the table previous slide from the investigation results of the sedimentation form in various parts of Japan.

it is possible to grasp the basic classification of sedimentation form and the position of sedimentation shoulder (altitude, longitudinal distance), prominent place of sedimentation, the relationship between operational water level and sedimentation, and the relationship between flood discharge and sedimentation height, and it is easy to understand the sedimentation characteristics and sedimentation tendency of the dam.



Example of dimensionless sedimentation form longitudinal figure (Type I)

3. Judgment of implementation on sedimentation countermeasure

① Understanding of sedimentation progress

1. Understanding of actual average annual sedimentation volume
2. Evaluation index and management level
3. Evaluation classification of sedimentation progress degree

↓

② Judgment on implementation of sedimentation countermeasure

↓

③ Consideration of necessary countermeasure volume

1. Calculation of estimated average annual sedimentation volume
2. Calculation of average annual residual sedimentation capacity
3. Calculation of annual necessary countermeasure volume
4. Consideration of possible volume of maintenance excavation

Figure: Concept of consideration (Flow)

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① Understanding of sedimentation progress

Table: Evaluation index and management level

The influence to be grasped	Evaluation index	Management level (guidance)	Sedimentation volume used for evaluation
Influence on reservoir function	① Sedimentation ratio to sedimentation capacity	70%	Total sedimentation volume
Influence on flood control function	② Sedimentation ratio to margin of flood control capacity	15%	Sedimentation volume within flood control capacity
Influence on reservoir function	③ Sedimentation ratio to effective water storage capacity	5%	Sedimentation volume within effective water storage capacity

② Judgment on implementation of sedimentation countermeasure

Table: Content of countermeasures according to the evaluation classification of sedimentation progression degree

Remaining years	Evaluation classification	Countermeasure content
Less than 20 years	A	Commencement of sedimentation countermeasure consideration
More than 20 years - less than 30 years	B	Implementation of investigation towards the commencement of sedimentation countermeasure consideration (Preliminary Survey + detailed investigation)
Over 30 years	C	Understanding of the sedimentation situation (Preliminary Survey)

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Table: Evaluation index and calculation method of remaining years

Evaluation index	Calculation method		
① Sedimentation ratio to sedimentation capacity	a	Remaining ratio until management level [%]	70% - (total sedimentation volume ÷ sedimentation capacity) × 100 [%]
	b	Estimated progress of sedimentation volume in the future [%/year]	[Actual average annual sedimentation volume (total volume) - average annual countermeasure volume (total volume) [1000 m^3/year] ÷ sedimentation capacity [1000 m^3] × 100
	c	Remaining years [year]	a/b
② Sedimentation ratio to margin of flood control capacity	a	Remaining ratio until management level [%]	15% - (Sedimentation volume within flood control capacity ÷ margin of flood control capacity) × 100 [%]
	b	Estimated progress of sedimentation volume in the future [%/year]	[Actual average annual sedimentation volume (within flood control capacity) - Average annual countermeasure volume (within flood control capacity)] [1000 m^3/year] ÷ margin of flood control capacity [1000 m^3] × 100
	c	Remaining years [year]	a/b
③ Sedimentation ratio to effective water storage capacity	a	Remaining ratio until management level [%]	5% - (Sedimentation volume within effective water storage capacity ÷ effective water storage capacity) × 100 [%]
	b	Estimated progress of sedimentation volume in the future [%/year]	[Actual average annual sedimentation volume (within effective water storage capacity) - Average annual countermeasure volume (within effective water storage capacity)] [1000 m^3/year] ÷ effective water storage capacity [1000 m^3] × 100
	c	Remaining years [year]	a/b

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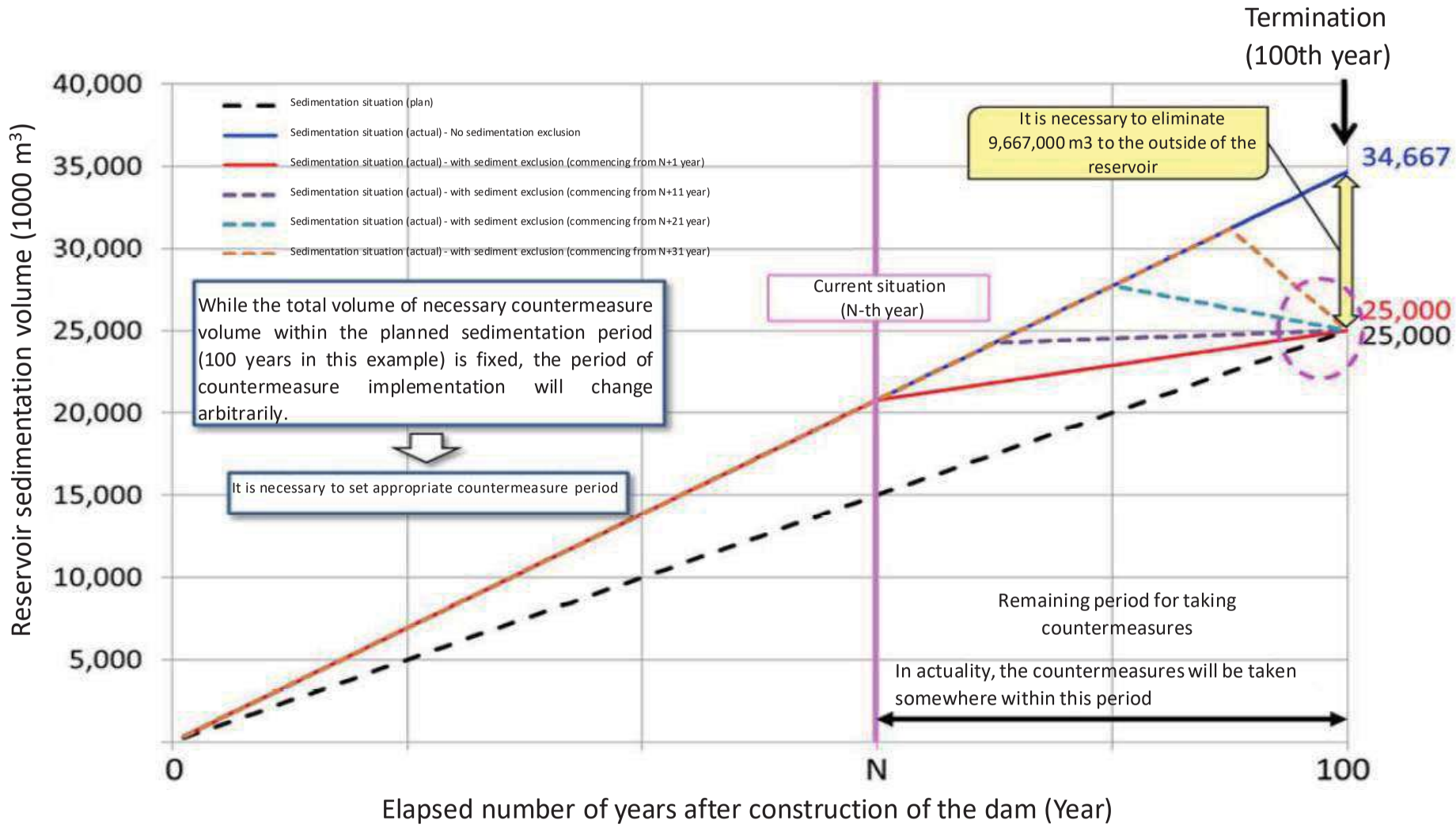
③Consideration of necessary countermeasure volume



Graph: Changes over time of reservoir sedimentation situation due to the presence or absence of countermeasure (Model Dam)

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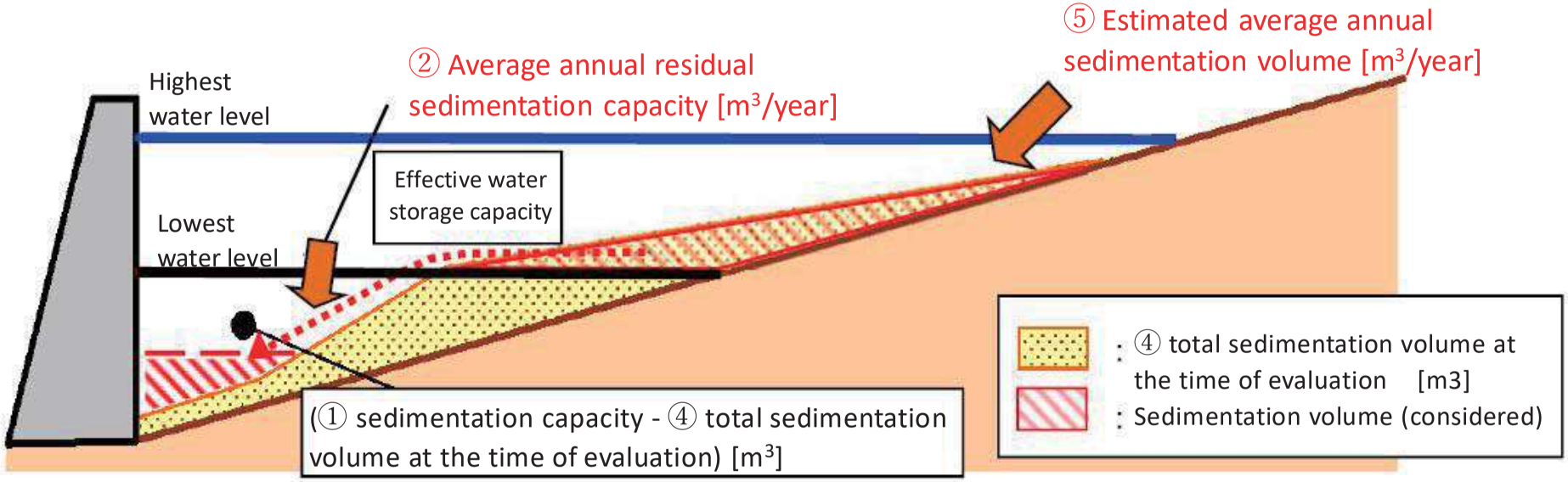
③Consideration of necessary countermeasure volume

"Concept of calculation of annual countermeasures necessary volume"

①Sedimentation capacity [m³]

②Average annual residual sedimentation capacity: (①sedimentation capacity - ④total sedimentation volume at the time of evaluation) / remaining service period [m³/year]

③ Annual countermeasure necessary volume: ⑤ Estimated average annual sedimentation volume - ②Average annual residual sedimentation capacity [m³/year]



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Initial screening of methods for Countermeasure for sedimentation

Table: Indexes for initial selection of countermeasure for sedimentation

Index	Content
CAP (Capacity)	Total reservoir capacity
MAR (Mean Annual Runoff)	Mean annual water inflow
MAS (Mean Annual Sediment Inflow)	Mean annual sediment inflow
CAP/MAR	1 / reservoir turnover rate
CAP/MAS	Total reservoir capacity / estimated mean annual sedimentation volume within the total reservoir capacity

◆ **Concerning the track record of implementation of countermeasure for sedimentation in dams all over Japan**

- From the data obtained in dams with countermeasure for sedimentation track record from among the dams managed by the Ministry of Land, Infrastructure and Transport and the Japan Water Agency in Japan, the relation between the 1/reservoir turnover rate (the ratio of total reservoir capacity relative to the mean annual water inflow) and the ratio of total reservoir capacity relative to the estimated mean annual sedimentation volume was established.
- It has been found that the application of these methods is constrained by the water volume: flushing and sluicing, which require the reservoir water level to be lowered; sediment bypass, which bifurcates the stream after raising the reservoir water level in order to secure the water use capacity; hydraulic suction method, which works better with higher reservoir level to ensure water head difference; and density current scouring, which requires the water in the reservoir to be stagnant.
- Excavation and dredging methods are not constrained by water volume.

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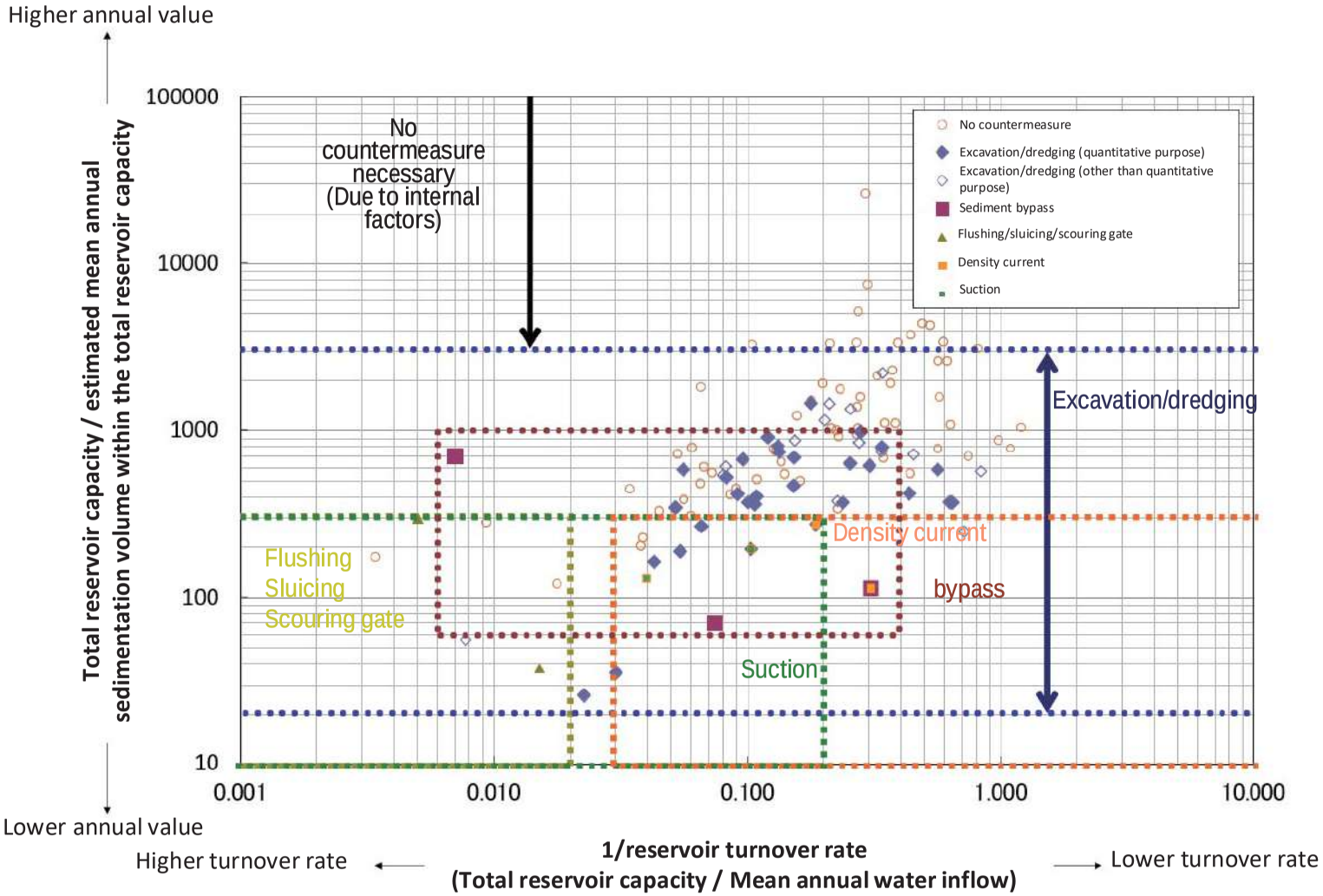

The dams plotted as having density current in the above are dams that are naturally resulted to be having density current and not artificially made to produce density current in a planned manner.

As there is no dam that currently implements suction (mechanical countermeasure), the dams plotted above are dams that are still in planning stage.

Figure: Selection diagram on countermeasures for sedimentation

Countermeasures for Sedimentation

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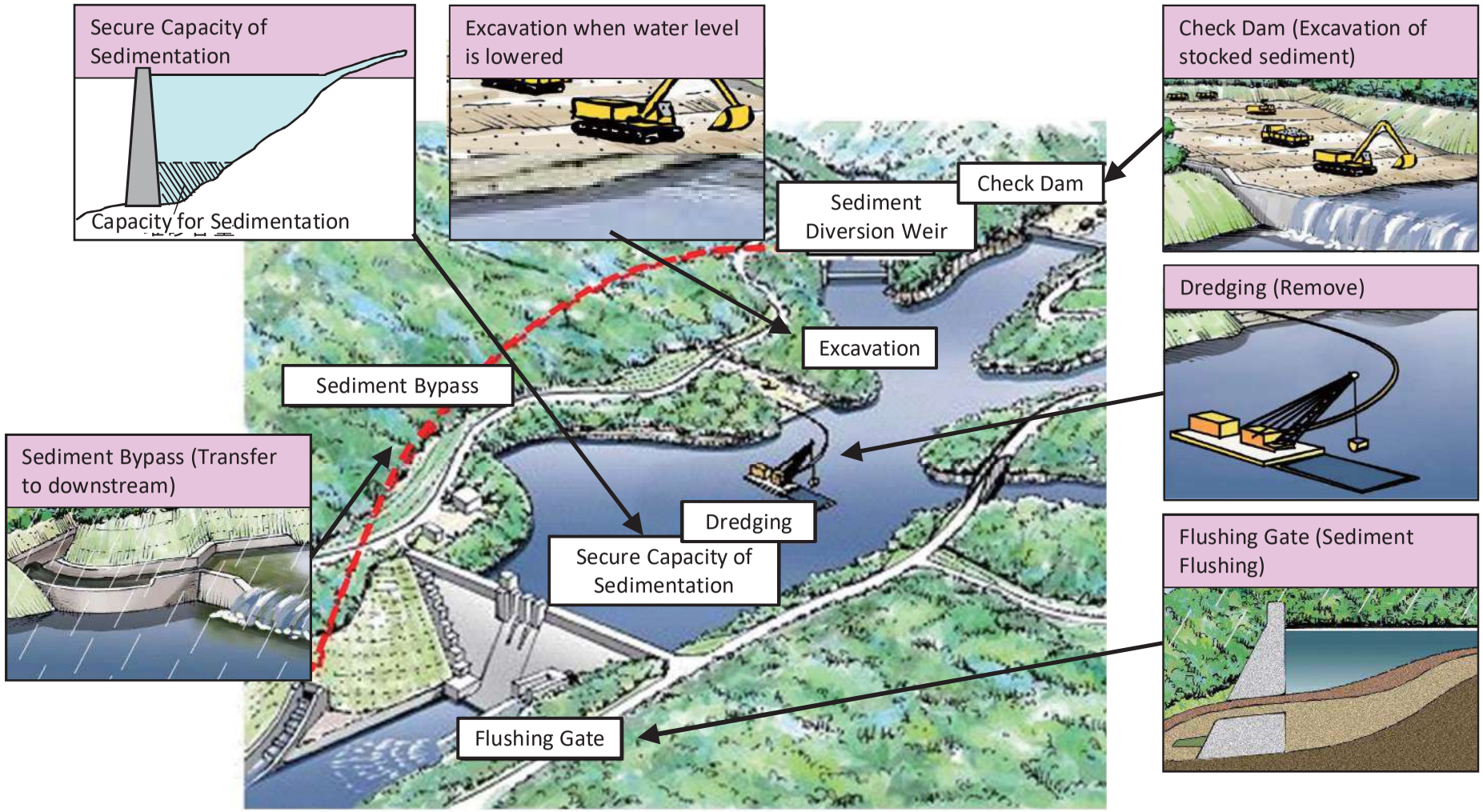
●Countermeasures for Sedimentation is implemented for preservation of reservoir capacity, function of inlet and outlet and inundation at upstream side of reservoir that are caused by sedimentation



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Countermeasures for Sedimentation

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Water Pressure Suction Method

●Utilizing the suction power caused by the elevation difference between the reservoir water level and discharge water level. Sedimentation of reservoir can be sucked out to the downstream

Image of Portable Type of Water Pressure Suction Method

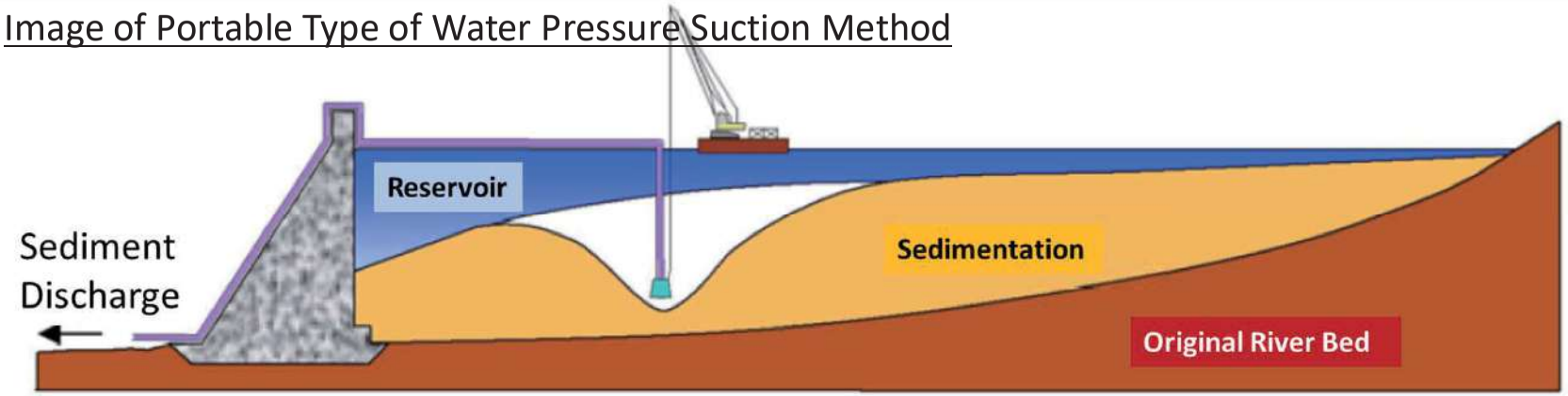
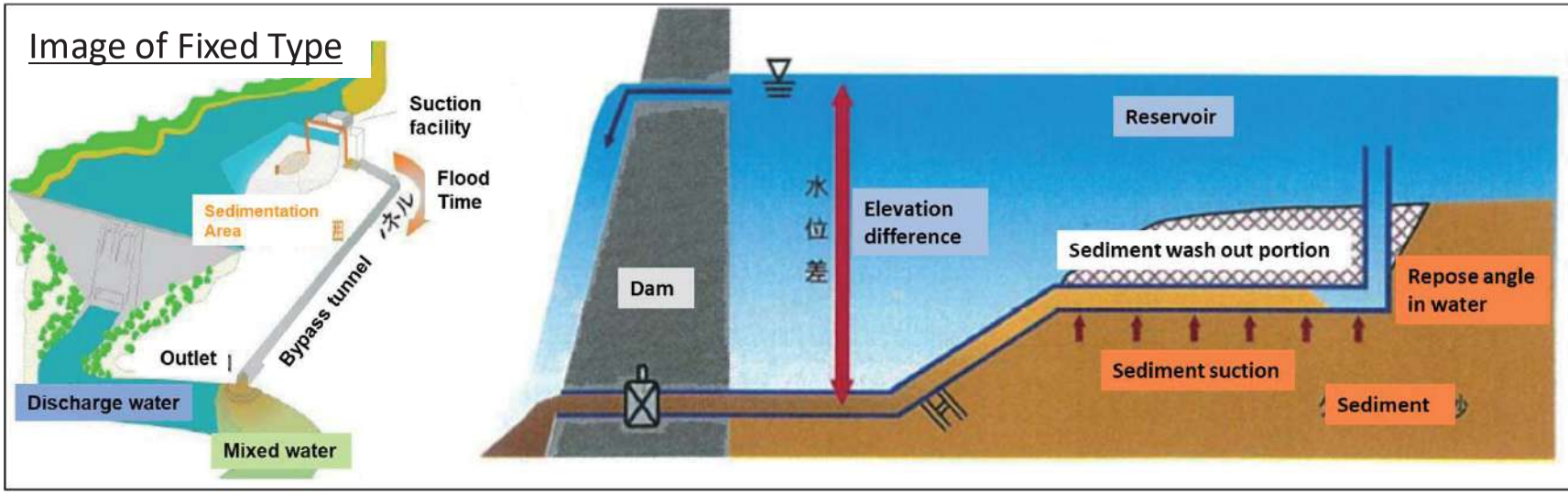


Image of Fixed Type



Countermeasures for Sedimentation

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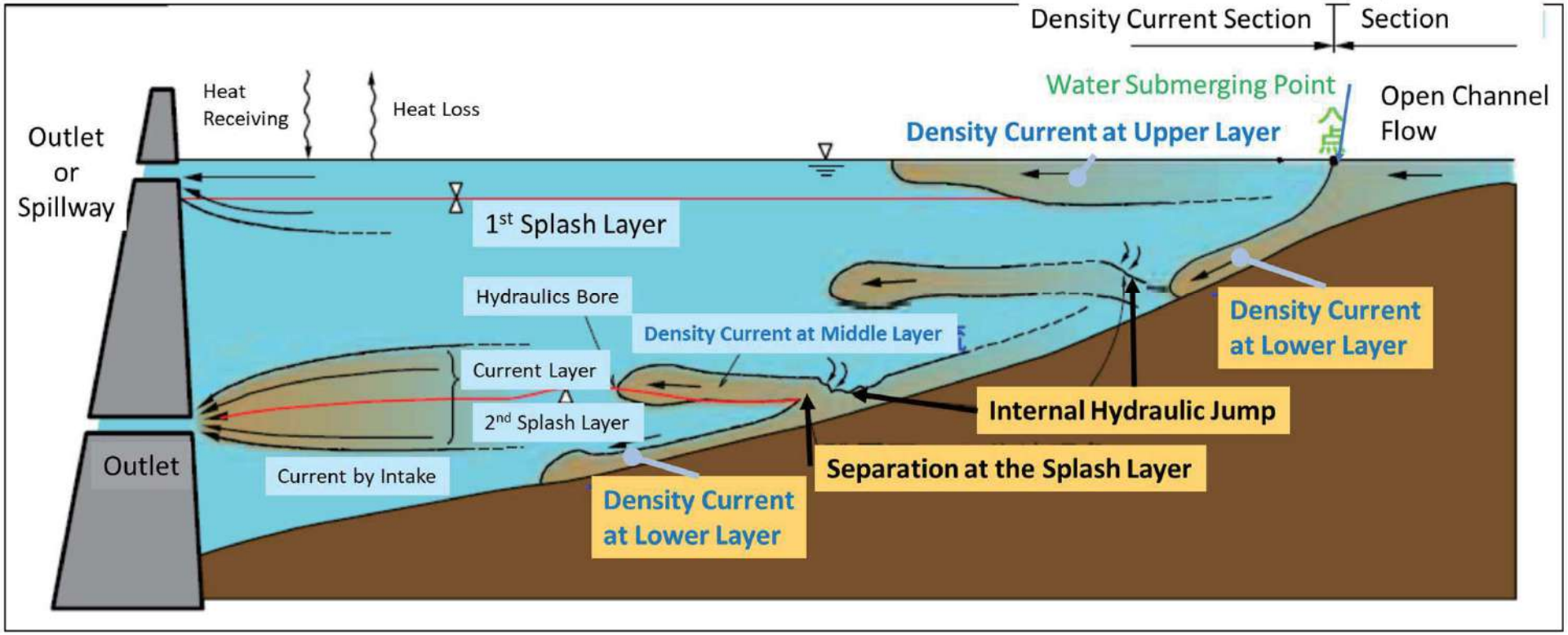
Density Current Discharge

●Lead the high-density flow* into reservoir bed and discharge Microsand to downstream during flood

*High-density flow with sediment is created at river bed by differences of water temperature

Image of Density Current Discharge



Necessary Conditions for Applying the Density Current Discharge

- MAR/CAP ≦ 10 MAR: Mean Annual Runoff, CAP: Reservoir Capacity
- H_D/H_{max} ≦ 0.5 H_D: Hydraulics Head at Outlet, H_{max}: Maximum Hydraulics Head

New Guideline on Sediment Management at Dam Reservoir

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Table: List of judgment on the possibility of application in accordance with constraints of each method

Judgment criteria	Flushing /sluicing	Sand bypass	Density current discharge
◆ It is possible to secure usable water volume ・ $\beta \leq 0.1$ Where β = Percentage of usable water volume relative to the mean annual water inflow at the time of scouring (= Reservoir capacity/Mean annual water inflow)	○	–	–
◆ Scouring gate or outlet is possible to be installed at low elevation ・ $H_D / H_{max} \leq 0.3$ [Flushing/sluicing] Where H_D = Water depth possible to be lowered by a gate H_{max} = Maximum water depth ・ $H_D / H_{max} \leq 0.5$ [Density current discharge] Where H_D = Water depth possible to be lowered by outlet H_{max} = Maximum water depth	○	–	○
◆ Will not bring adverse effect to the downstream environment during scouring	○	–	–

New Guideline on Sediment Management at Dam Reservoir

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(Continued)

Table: List of judgment on the possibility of application in accordance with constraints of each method

Judgment criteria	Flushing /sluicing	Sand bypass	Density current discharge
◆ Reservoir shape is suitable for facility installation ・ (River channel type: Reservoir is formed on a single river channel) or (Tributary confluence type: Reservoir is formed by inflow from two river channels)	–	○	–
◆ It is possible to secure tractive force within the tunnel ・ $I \geq 1/100$ Where I = Tunnel inclination	–	○	–
◆ Satisfies factors such as constraints in facility plan or design (upper limit reference value) ・ Reservoir catchment area (400km^2) / Extent (10km) ・ Design discharge (400m^3/s) / Design stream velocity (15m/s)	–	○	–
◆ Conditions for occurrence of density current ・ Reservoir turnover rate $(MAR\ /CAP) \leq 10$	–	–	○
Number of corresponding criteria for consideration	/3	/3	/2
Judgment on applicability: Mark applicable method with ● symbol (* Applicable = corresponds to all criteria for consideration)			

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Conclusion

- New "MLIT's Vision to Upgrade Dams under Operation" and "Guideline on Sediment Management at Dam Reservoir" can be contributed for "Innovation" of Dam Operation & Maintenance in Indonesia as adequate references and examples

- JICA Project on Capacity Development for RBOs (BBWS and BWS) will organize opportunities to introduce "Dam Upgrading under Operation" and technical method of survey/observation/research/countermeasure for Dam Sedimentation

Terima Kasih

ありがとうございました。

Information

INACOLD Seminar in Batam

Group Discussion on Dam Operation & Maintenance in INACOLD

"Exchanging Experience and latest technology for Dam Operation and Maintenance"

Data : 14:00 – 17:00, 24th October 2018

Venue : Batam (Tentative: Aston Batam Hotel & Residence)

Topics : New Vision and Technical Guidelines on Existing Dams in Japan

Practical dam operation & maintenance works in Japan

MANAGEMENT PENGELOLAAN SEDIMENTASI WADUK

M. Adek Rizaldi

Manado, 15 Agustus 2018

SUBDIT O&P BENDUNGAN DAN DANAU

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
DIREKTORAT BINA OPERASI DAN PEMELIHARAAN
Jl. Pattimura No. 20, Gedung SDA Lantai 5 Kebayoran Baru Jakarta Selatan, 12110 Telp. : (021) 7395500 – Fax (021) 7246312

Outline:

I. DASAR HUKUM

II. LATAR BELAKANG

III. PETA SEBARAN BENDUNGAN

IV. PENGELOLAAN SEDIMENTASI WADUK

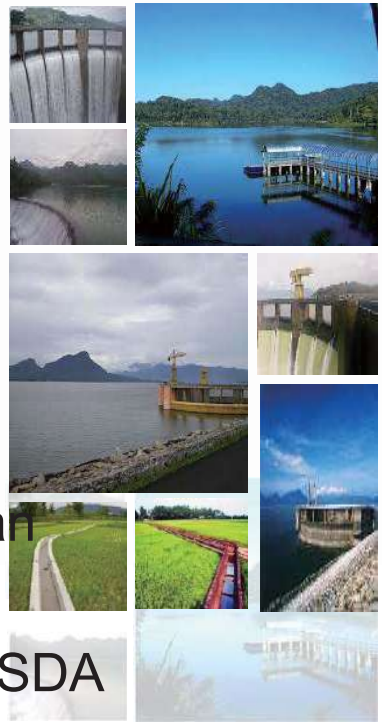
V. PENANGANAN SEDIMENTASI WADUK

- PENANGANAN STRUKTURAL
- PENANGANAN NON-STRUKTURAL

A6-3-No.005-36

1 DASAR HUKUM

I. DASAR HUKUM

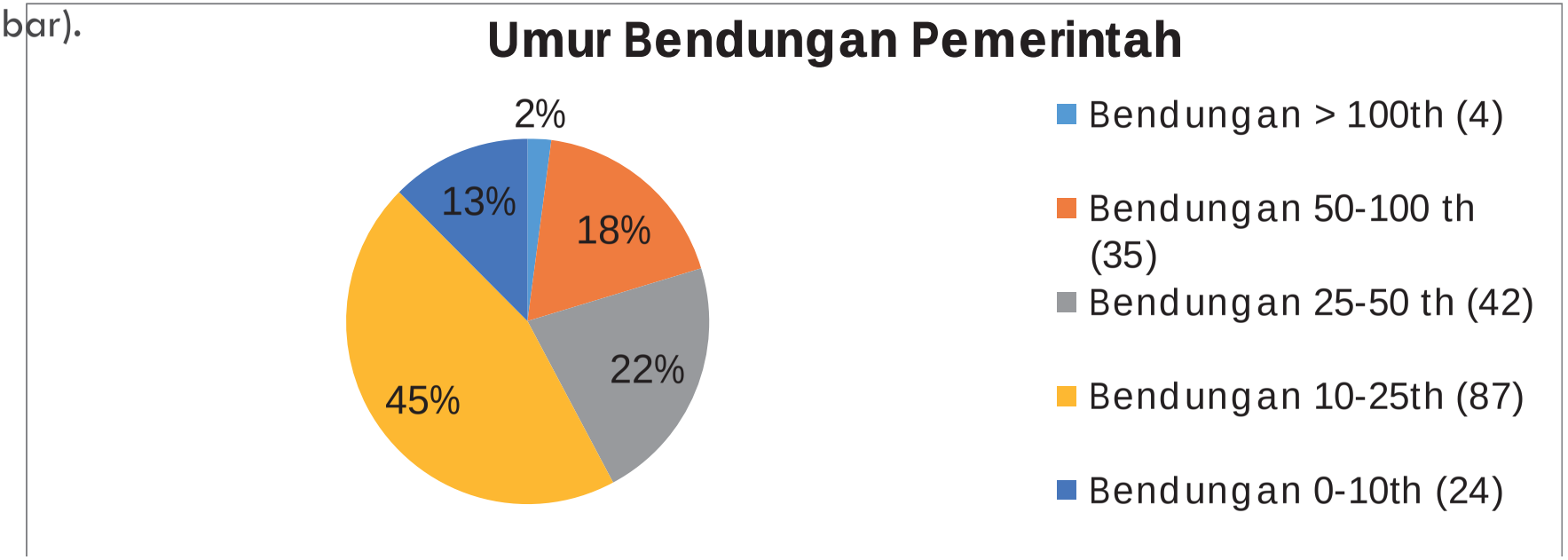


- UU No. 11 Tahun 1974 tentang Pengairan
- UU No. 26 Tahun 2007 tentang Penataan Ruang
- PP No. 22 Tahun 1982 tentang Tata Pengaturan Air
- PP No. 35 Tahun 1991 tentang Sungai (ps.15)
- Permen PUPR No. 06/PRT/2015 tentang Eksploitasi dan Pemeliharaan SDA dan Bangunan Pengairan
- Permen PUPR No. 09/PRT/2015 tentang Penggunaan SDA
- Permen PUPR No. 27/PRT/2015 tentang Bendungan
- Keputusan Dirjen SDA No.199/KPTS/2003 tentang Pedoman Operasi, Pemeliharaan dan Pengamatan Bendungan
- Pedoman Pengelolaan Sedimentasi Waduk Tahun 2004

2 LATAR BELAKANG

II. LATAR BELAKANG

- Jumlah Bendungan di Indonesia 224, 192 milik Pemerintah/Kementerian PUPR (6,999 milyar m3) dan 32 milik BUMN/Swasta
- Sejarah pembangunan bendungan di Indonesia dimulai sekitar tahun 1910-1917 dengan dibangunnya bendungan Nglangon, Tempuran di Jateng, bendungan Prijetan (Jatim) dan bendungan PLTA Cileunca (Jabar).
- Bendungan Indonesia umumnya sudah tua mempunyai masalah **fungsi layanan** dan **keamanan** (penumpukan sedimen di waduk yang mengganggu operasi dan keamanan).
- Total sedimentasi bendungan 988 jt m3 (12,37%)



3 SEBARAN BENDUNGAN INDONESIA

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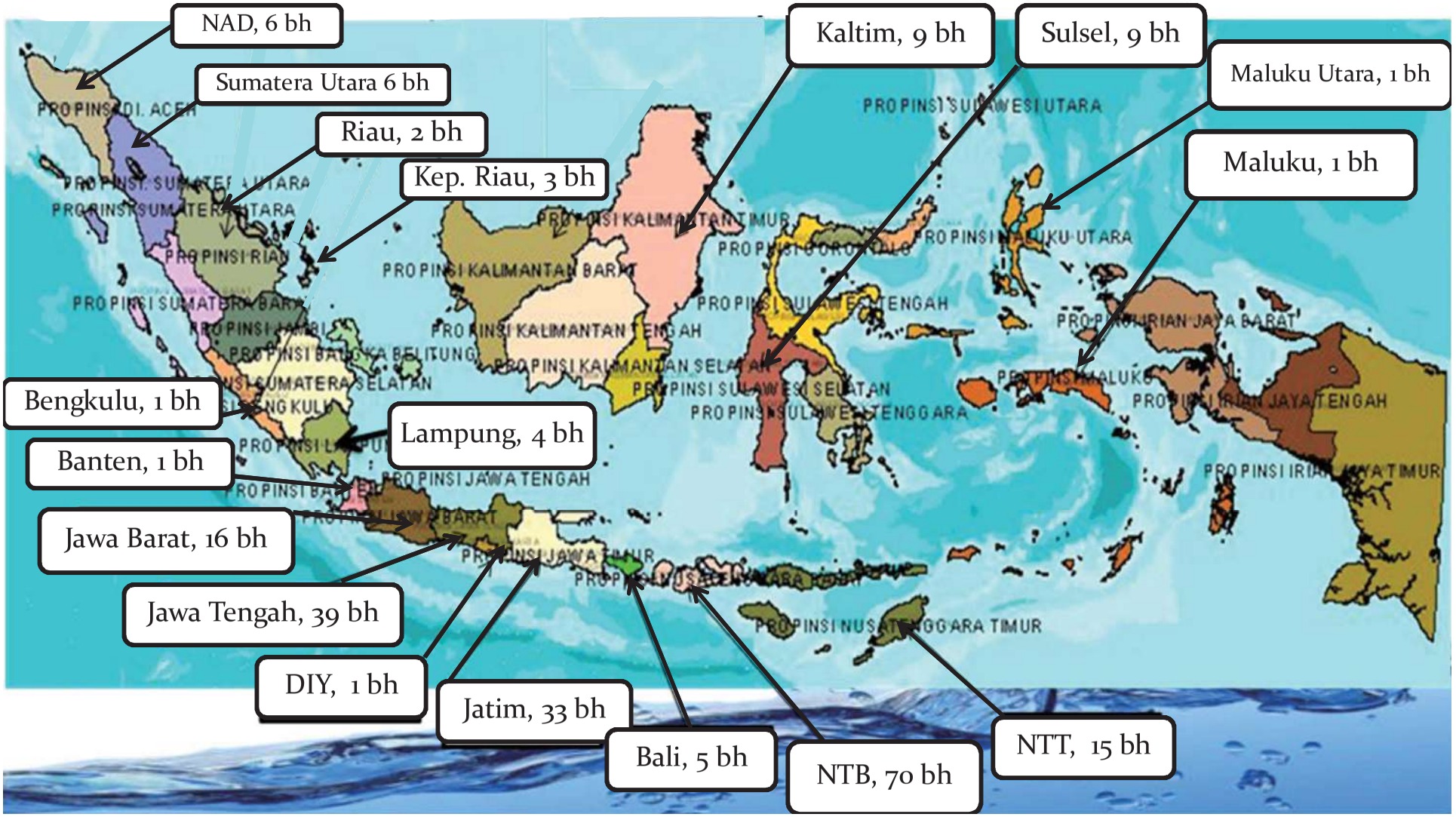
III. Sebaran Bendungan Indonesia

(Kriteria PERMEN PUPR No 27/PRT/M/2015)

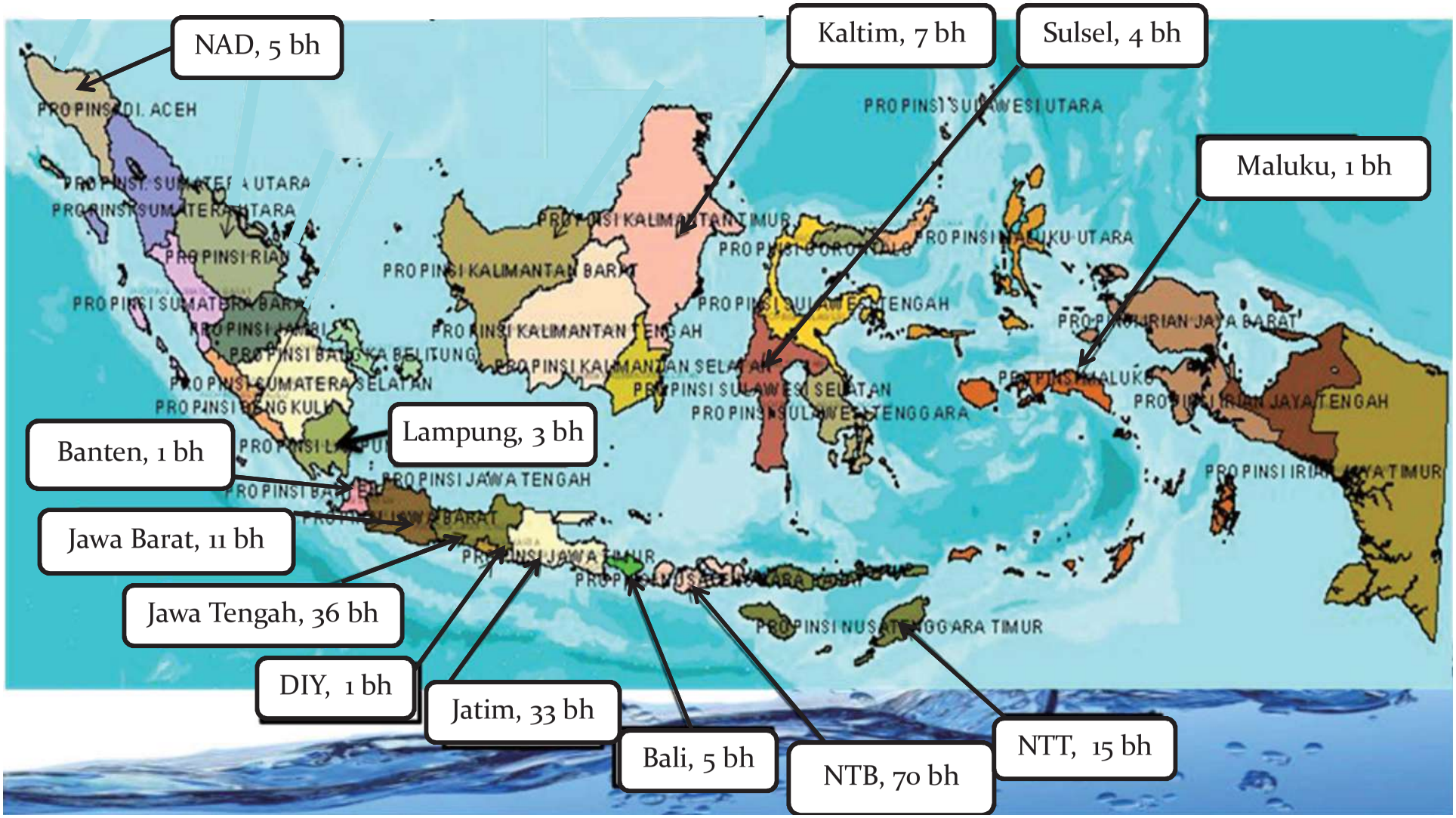
TOTAL: 224 bendungan tersebar di 13 Provinsi



Sebaran Bendungan Milik Kementerian PUPR

(Kriteria PERMEN PUPR No. 27/PRT/M/2015)

TOTAL: 192 bendungan tersebar di 13 Provinsi



4 PENGELOLAAN SEDIMENTASI WADUK

IV. PENGELOLAAN SEDIMENTASI WADUK

STRATEGI PENGELOLAAN SEDIMENTASI

MENGURANGI LAJU SEDIMENTASI DI DAERAH TANGKAPAN

- Menekan laju erosi kawasan hulu
- Meminimalkan beban sedimen yang masuk ke waduk

MENGURANGI LAJU SEDIMENTASI DI WADUK

- Meminimalkan jumlah sedimen yang mengendap di waduk
- Mengeluarkan endapan sedimen di waduk

PENGELOLAAN SEDIMENTASI WADUK

FAKTOR-FAKTOR YANG MEMPENGARUHI SEDIMENTASI WADUK

FISIOGRAFI

- Tipe tanah
- Penutup lahan
- Tataguna lahan
- Topografi lahan
- Kerapatan jaringan drainase
- Morfologi sungai
- Karakteristik sedimen
- Karasteristik hidraulik sistem alur
- Laju erosi lahan
- Sistem alur

HIDROKLIMATOLOGI

- Hujan (jumlah & intesintas)
- Iklim di daerah tangkapan
- Respon kejadian

AKTIVITAS MANUSIA

- Pemanfaatan hasil hutan
- Pembangunan permukiman
- Pengelolaan tanah
- Pembangunan Infrastruktur

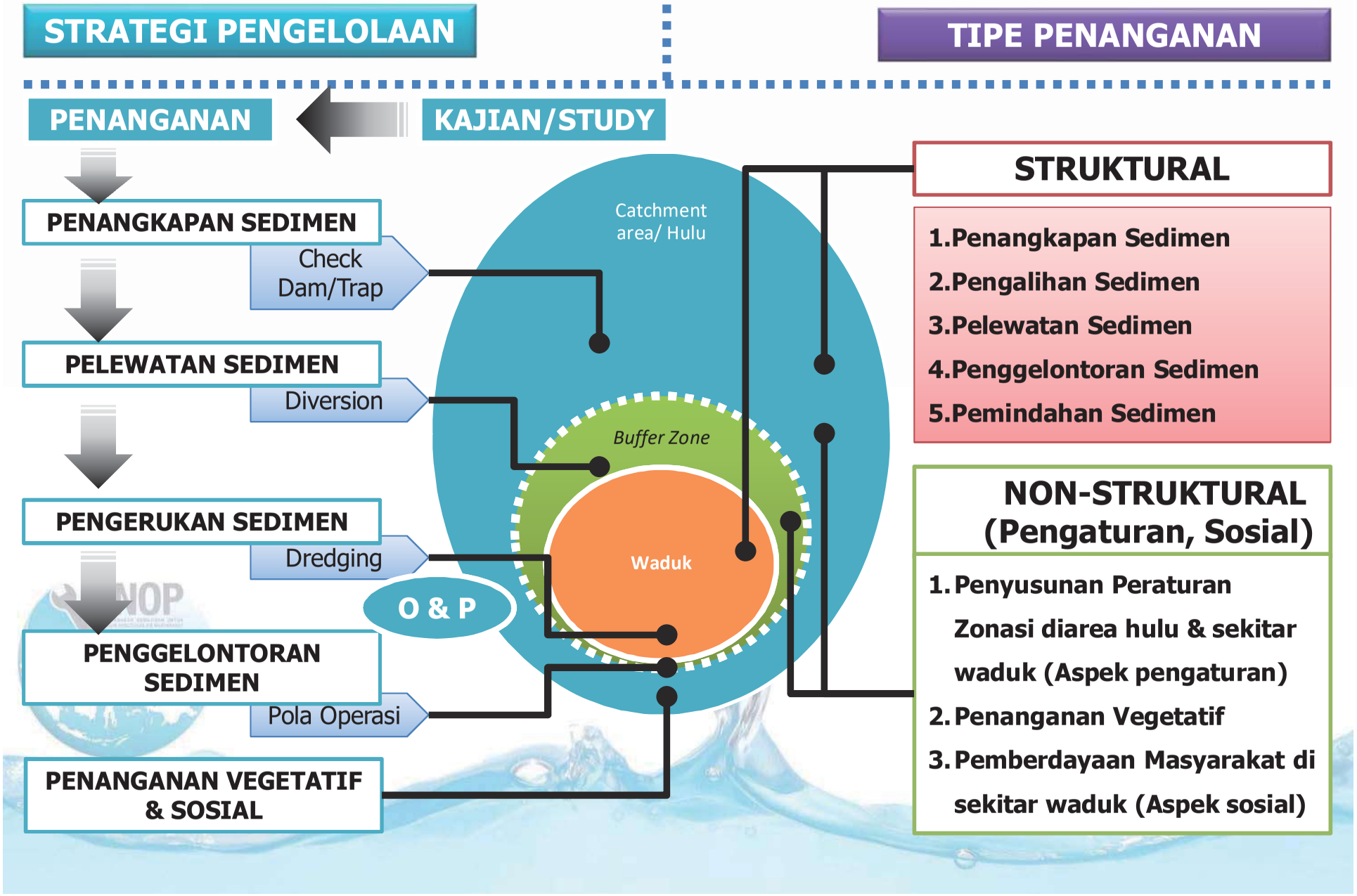
EROSI LAHAN

- Erosi lempeng (*Sheet Erosion*)
- Erosi riils (*Riil Erosion*)
- Erosi alur (*Gully Erosion*)

POLA OPERASI WADUK

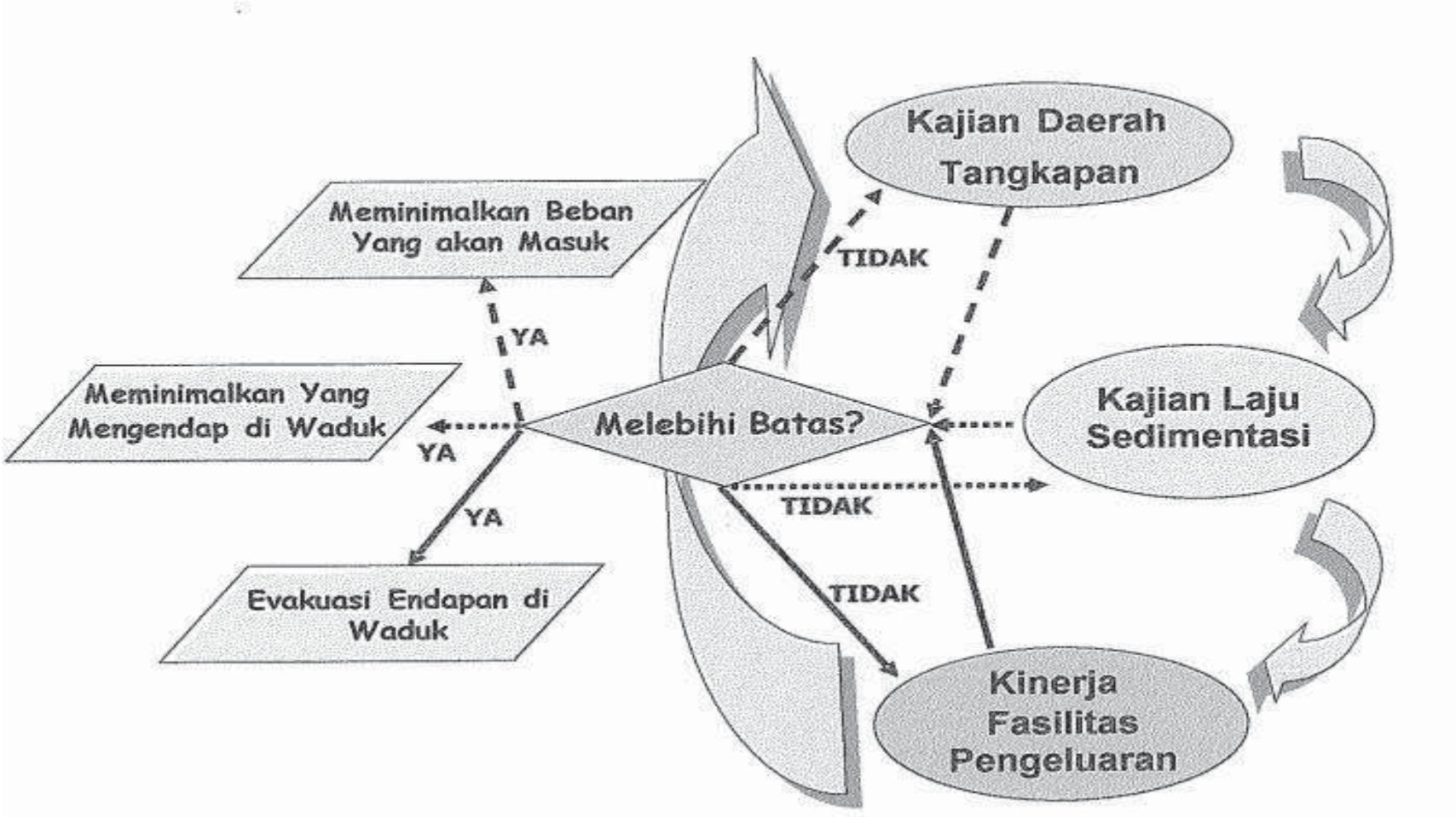
- Laju sedimentasi
- Jenis butiran sedimen

PENGELOLAAN SEDIMENTASI WADUK



5 PENANGANAN SEDIMENTASI WADUK

V. PENANGANAN SEDIMENTASI WADUK



SKEMA PENANGANAN

PENANGANAN SEDIMENTASI

CARA PENANGANAN SEDIMEN

STRUKTURAL

1. PENANGKAPAN SEDIMEN DI HULU WADUK
2. PENGALIHAN SEDIMEN MASUK KE WADUK
3. PELEWATAN SEDIMEN MELALUI WADUK
4. PENGGELONTORAN SEDIMEN DI WADUK
5. PEMINDAHAN SEDIMEN DARI WADUK

NON – STRUKTURAL (ASPEK PENGATURAN, SOSIAL)

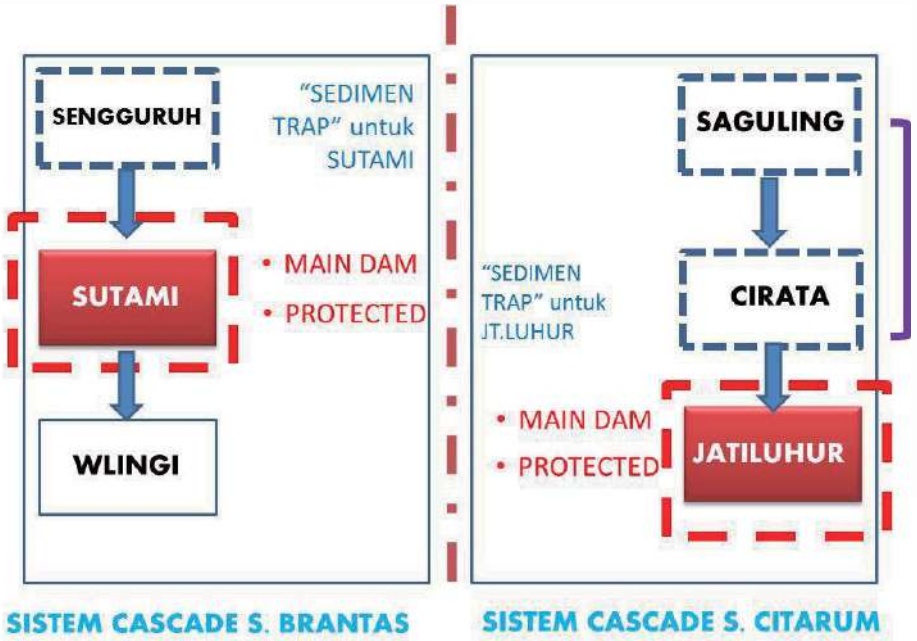
1. PEYUSUNAN ZONASI
2. PENANGANAN SECARA VEGETATIF
3. PENANGANAN SECARA SOSIAL

PENANGANAN STRUKTURAL

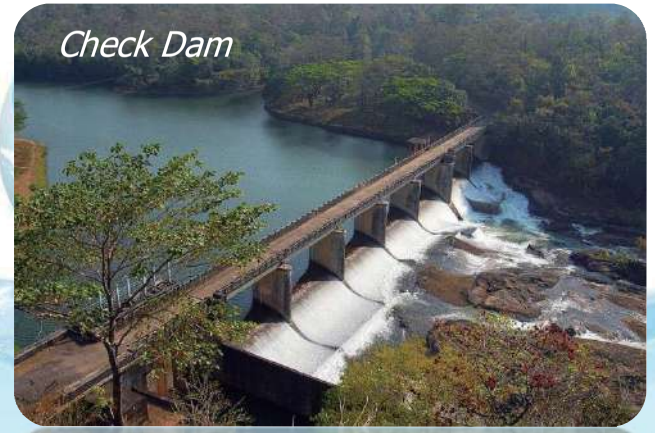
1. **Penangkapan Sedimen**
   a. Membangun Check Dam/Sedimen trap
   b. Membangun sistem kaskade

2. **Pengalihan, Pelewatan dan Penggelontoran (Flushing) Sedimen**
   a. Membangun Pengelak/Diversion
   b. Pengaturan Pola Operasi → pada periode tertentu mengoperasikan bottom outlet

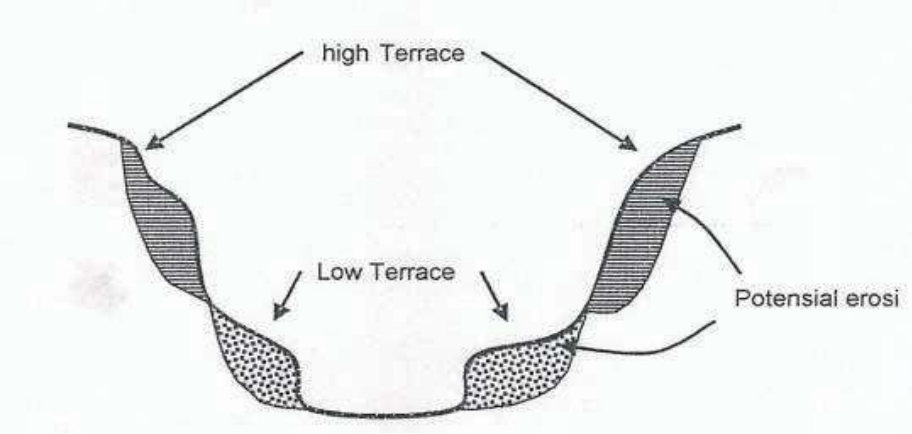
3. **Pengerukan/dredging**



Sistem Kaskade/seri

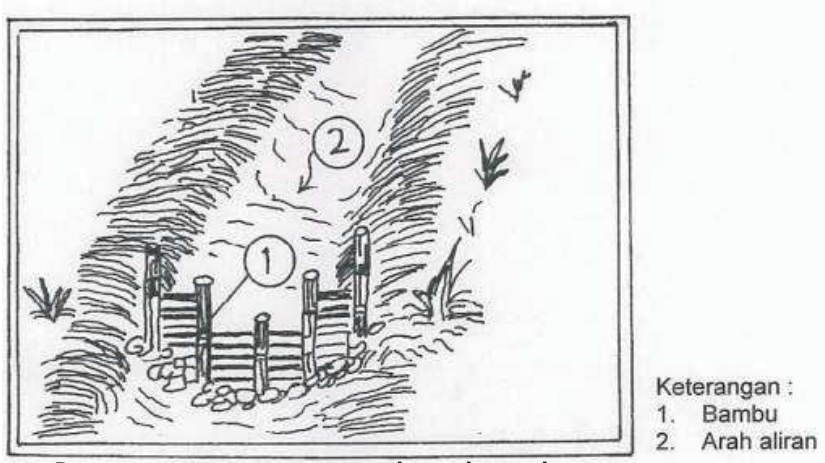


1. PENANGKAPAN SEDIMEN DI HULU WADUK

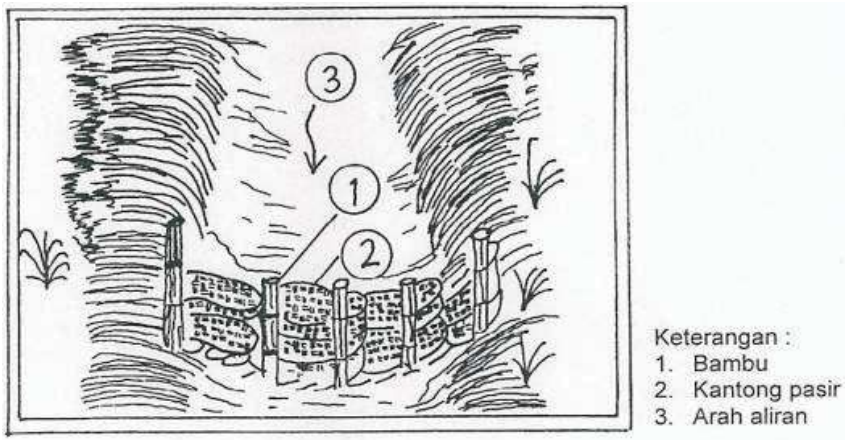


High Terrace dan *Low Terrace* sebagai sumber sedimen

- Bangunan Penangkap Sedimen
- Bangunan Penahan Sedimen (*Checkdam*)
- Penyumbatan Alur *(Gully Plug)*
- Sistem Teras (Sengekedan/Terassering)
- Perbaikan Saluran Alami



Bangunan terjunan dari bambu



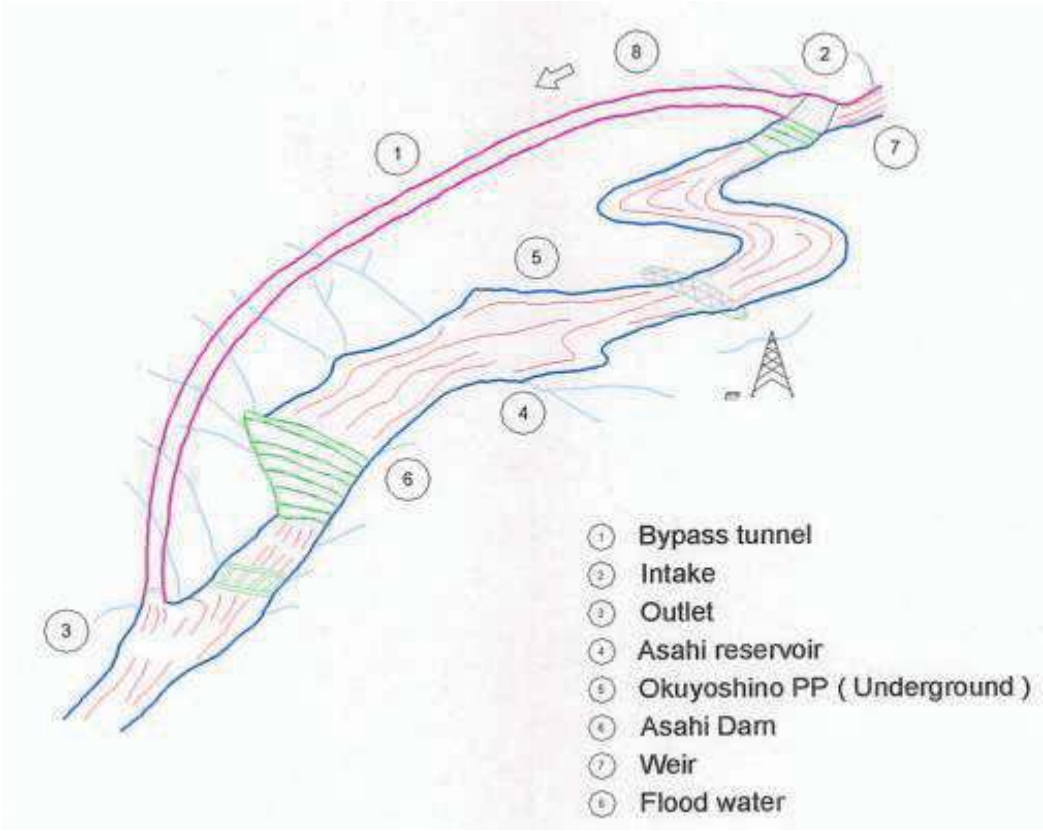
Bangunan terjunan dari kantung

2. PENGALIHAN SEDIMEN MASUK KE WADUK

- Pengalihan sedimen dilakukan dengan membuat bangunan pengelak atau *diversion* yang berfungsi untuk membelokkan aliran yang mengangkut sejumlah material, baik sebagai angkutan dasar ataupun angkutan melayang.

- Bagian atau komponen bangunan pengalihan sedimen seluruhnya terdiri dari
  a) Bendung pengarah aliran
  b) Bangunan pengambil (*intake*)
  c) Terowongan atau saluran pengelak
  d) Bangunan keluaran (*outlet*)

PENGALIHAN SEDIMEN YANG MASUK WADUK



Contoh Bangunan Pengalihan Bendungan Asahi

- Tata Pengoperasian Bangunan Pengalihan Sedimen
  1. Pengoperasian Musim Hujan
  2. Pengoperasian Musim Kemarau

3. PELEWATAN SEDIMEN MELALUI WADUK

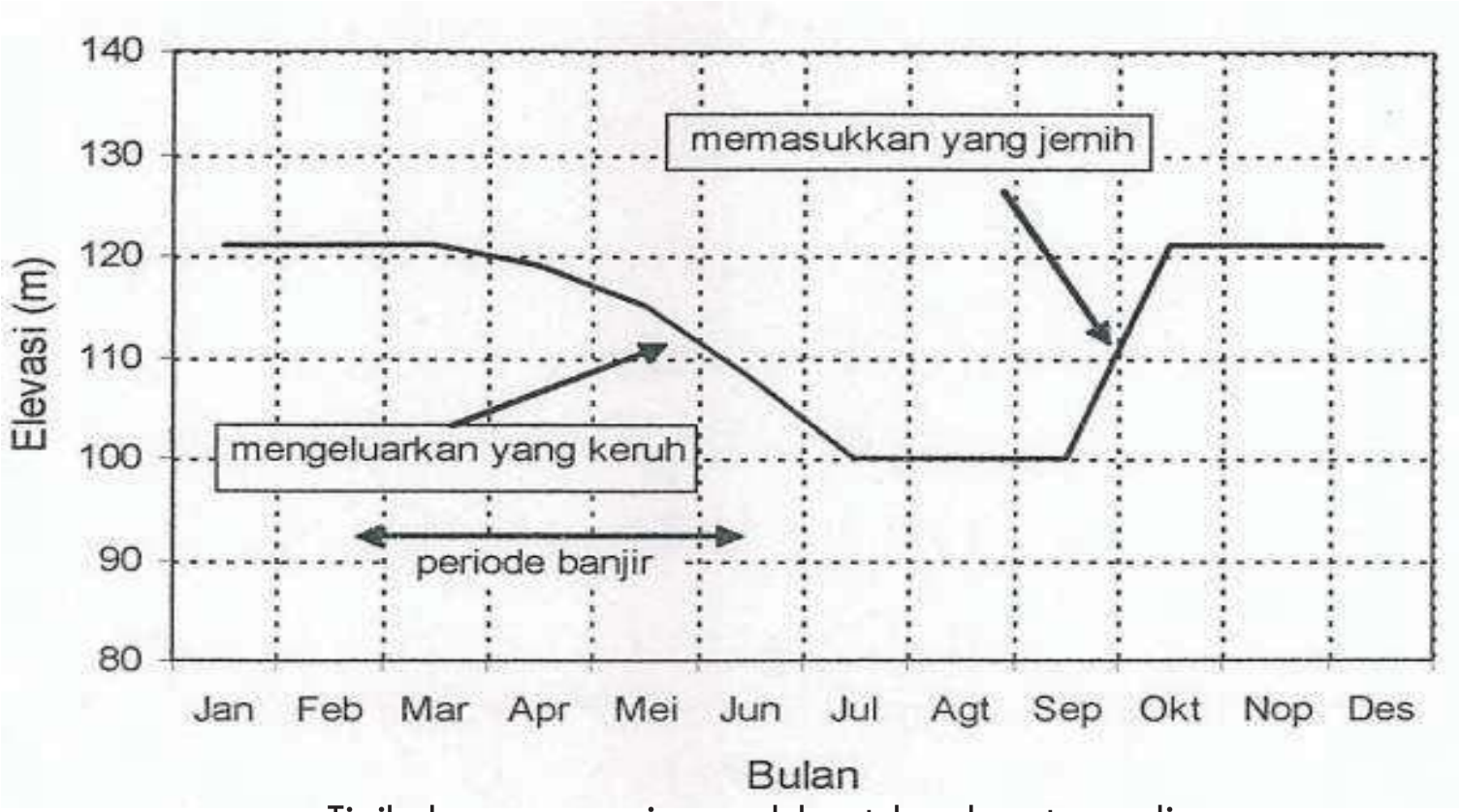
- Pelewatan sedimen melalui waduk diartikan sebagai usaha menghindari terjadinya pengendapan sedimen yang sudah terlanjur masuk ke dalam waduk. Tindakan pelewatan dilakukan dengan sistem pengoperasian bangunan keluaran bawah (*bottom outlet)* dengan mempertimbangkan :
  - Tersedia volume air yang cukup selama waktu pelewatan sedimen
  - Bentuk kolam waduk memanjang
  - Jenis sedimen yang di keluarkan mempunyai ukuran kecil

PELEWATAN SEDIMEN MELALUI WADUK

- Persyaratan Hidraulik
  1. Tersedianya bangunan keluaran bawah *(bottom outlet)* yang cukup, baik tata letak maupun dimensinya,
  2. Bangunan keluaran bawah tersebut dilengkapi dengan pintu yang dapat dioperasikan dengan mudah,
  3. Bentuk tampungan waduk memadai, yaitu dalam bentuk memanjang, lebar tidak sangat bervariasi, dan tidak mendering (berbelok-belok)

PELEWATAN SEDIMEN MELALUI WADUK

- Teknik Pengoperasian



Tipikal pengoperasian waduk untuk pelewatan sedimen

4.PENGGELONTORAN SEDIMEN KELUAR WADUK

- Penggelontoran *(flushing)* sedimen yang ada di waduk merupakan suatu usaha pengeluaran endapan di waduk dengan cara penguraian endapan kemudian dikeluarkan melalui *bottom outlet*.
- Beberapa persyaratan umum yan diperlukan :
  - Bentuk kolam waduk relatif sempit
  - Tersedia volume air yang cukup besar
  - Kondisi waduk memungkinkan untuk dilakukan pengosongan dalam jumlah relatif besar

PENGGELONTORAN SEDIMEN KELUAR WADUK

- Kriteria Keberhasilan Penggelontoran:
  1. Annandala (1998) : Keberhasilan ditunjukkan pada nilai tampungan yang diperoleh dimana rasio kapasitas tampungan dengan aliran masuk setahun adalah > 0,02
  2. Pill dan Thompson (1984) : Efektif pada kondisi dimana penurunan elevasi muka air mencapai setinggi tinggi bendungan dan kapasitas pengeluaran mencapai sekurangnya dua kali aliran masuk rerata tahunan
  3. Atkuisan (1996) : Penggelontoran berhasil jika :
     - Jumlah sedimen yang digelontorkan melalui *outlet* mencukupi untuk memelihara kesinambungan antara sedimen yang masuk dan yang digelontor untuk jangka waktu yang lebih panjang
     - Volume endapan yang tertinggal di waduk setelah penggelontoran relatif kecil sehingga diperoleh volume tampungan yang diisyarakatkan
     - Biaya penggelontoran tidak melebihi manfaat yang diperoleh dari kegiatan penggelontoran.

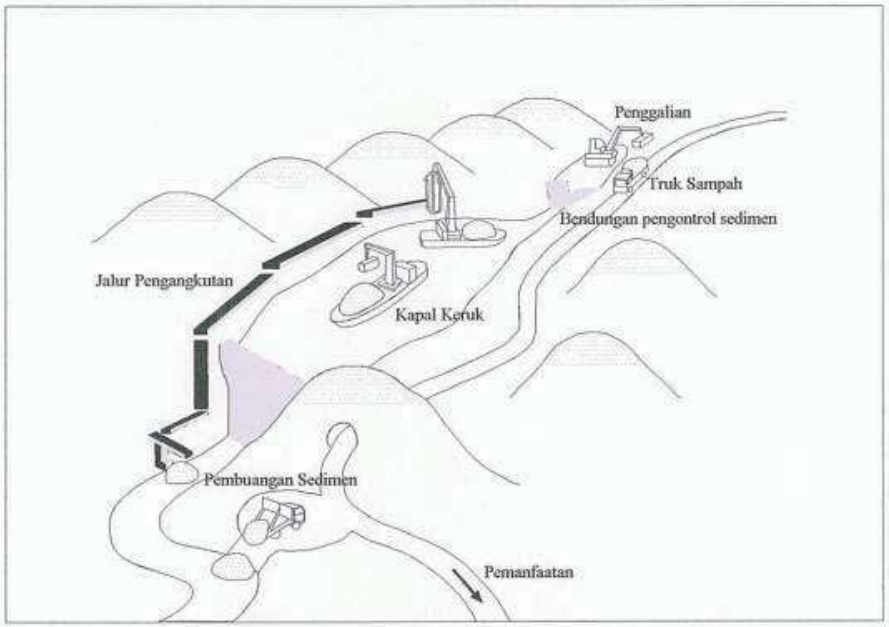
5. PEMBUANGAN SEDIMEN DARI WADUK SECARA MEKANIS

- Pelaksanaan pembuangan sedimen dari waduk dilakukan dengan mempetimbangkan :
  a) Ketersediaan peralatan
  b) Daerah yang dijadikan *disposal area*
  c) Jarak jangkauan
  d) Masalah lingkungan yang terkait

- Metode pembuangan :
  a) Ketersediaan peralatan
  b) Daerah yang dijadikan tempat pembuangan
  c) Jarak jangkauan
  d) Masalah lingkungan yang terkait

PEMBUANGAN SEDIMEN DARI WADUK SECARA MEKANIS

- Ekonomi dan Lingkungan :
  1. Jenis dan volume endapan
  2. Lokasi pembuangan hasil pengerukan
  3. Harga pembebasan lahan untuk pembuangan sedimen hasil pengerukan
  4. Peralatan dan teknik pengerukan yang digunakan



Skema Pengerukan Sedimentasi Waduk

Kapal Keruk

2. Aspek Sosial

Kolaboratif - Partisipatif

PENANGANAN SECARA VEGETATIF

- Usaha pengelola tanah di kawasan hulu perlu disertai dengan kegiatan pengolahan tanah dan tanaman:
  1. Pola tanam ganda *(Multiple cropping), tumpang sari*
  2. Pola tanam berjajar *(Strip cropping)*
  3. Pemberian mulsa
  4. Pemberian pupuk organik
- Erosi kawasan hulu
  1. Hujan
  2. Kondisi topografi
  3. Kondisi geologi
  4. Kondisi tanah
  5. Daerah rawan erosi/kritis
  6. Tataguna lahan
  7. Jenis tanaman

PENANGANAN SECARA VEGETATIF

- Zonasi tataguna lahan dan deskripsi penanganan kawasan hulu

Tabel. Zona tataguna lahan

Zona	Sub zona	Kemiringan	Konsep dasar tataguna lahan
Zona P		> 40 %	Pelaksanaan perlindungan(khususnya perlindungan dengan tanaman hutan lindung)
Zona A – P	Sub zona Am – P	8 – 40 %	Pelaksanaan pertanian pada lahan konservasi (khususnya untuk hutan agro atau pertanian)
	Sub zona Aw – P	8 – 40 %	Konservasi pada daerah tepi genangan waduk sebagai penopang reservoar bendungan dan muara sungai
Zona A		< 8 %	Pelaksanaan pertanian intensif (khususnya untuk pengembangan lahan)
Zona S			Lahan pemukiman

Sumber : Watershed Conservation Masterplan in Brantas River Basin

PENANGANAN SECARA VEGETATIF

Tabel. Tipikal penanganan lahan dengan kemiringan < 40%

Daerah	Kemiringan tanah				
	< 8 %	8 – 15 %	15 – 25 %	25 – 40 %	> 40 %
Tanah kering	Tanaman pembatas	Perlindungan hutan agro dengan kerapatan rendah pembuatan terasering	Perlindungan hutan agro dengan kerapatan sedang atau pembuatan terasering	Perlidungan hutan agro dengan kerapatan tinggi atau pembuatan terasering	Perlidungan sebagai hutan lindung (daerah yang tidak cocok untuklahan pertanian)
Tepi genangan	Tepi waduk dengan sabuk hijau selebar 10 – 30m Tepi sungai dengan sabuk hijau selebar 10 – 20m				
Tebing di tepi jalan	Dinding penahan longsoran, saluran drainase, penghijauan dan perlindungan tanah				

Sumber : Watershed Conservation Masterplan in Brantas River Basin

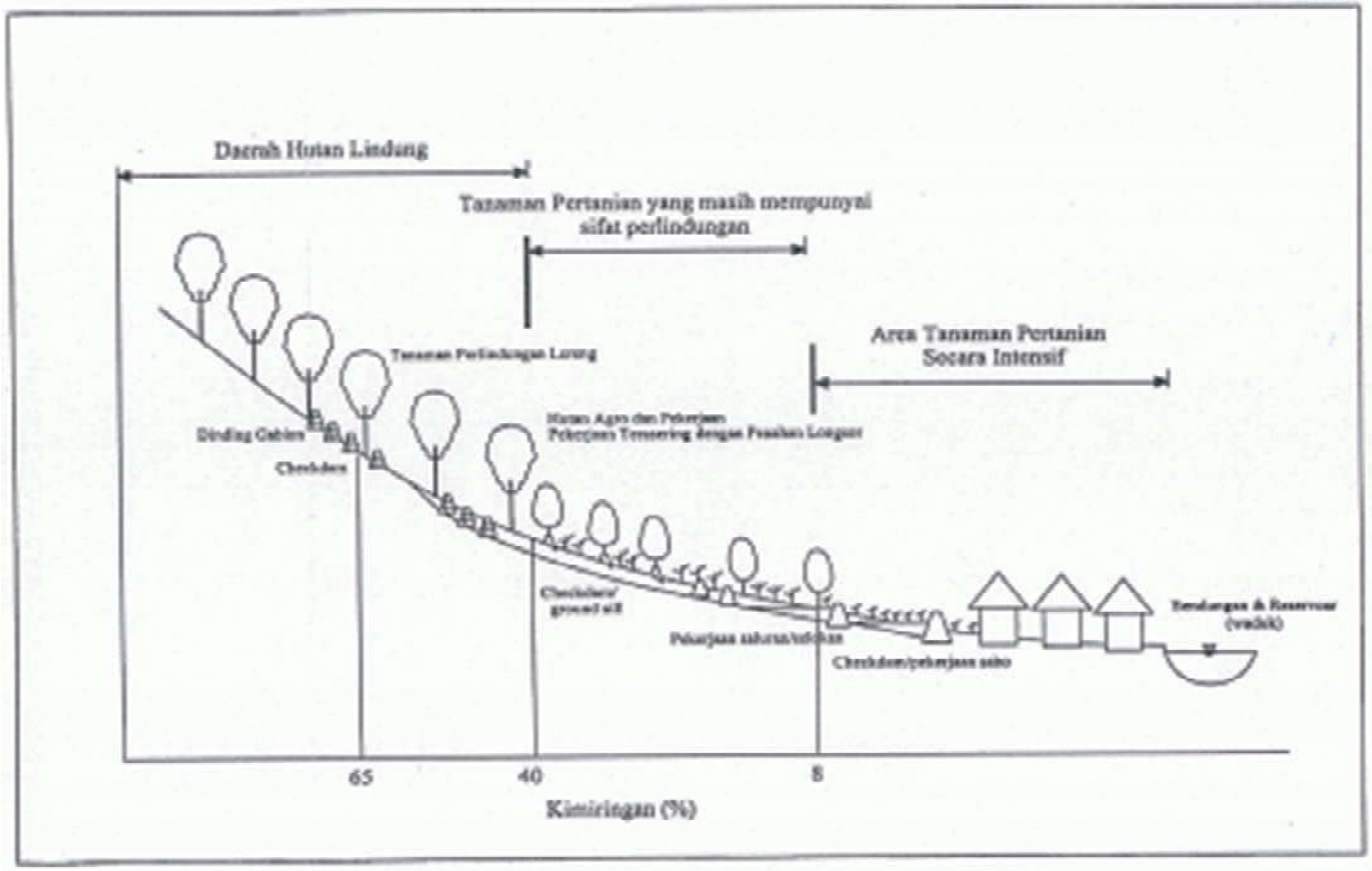
Tabel. Tipikal penanganan lahan dengan kemiringan >40 %

Daerah	Kemiringan tanah		
	< 40 %	40 – 65 %	> 60 %
Hutan yang mengalami kerusakan	Terasering, penghijauan, perbaikan tanah	Dinding penahan tanah, terasering, penghijauan, perbaikan tanah	Penyumbatan alur, pembuatan dinding penahan tanah, penghijauan, perbaikan tanah

Sumber : Watershed Conservation Masterplan in Brantas River Basin

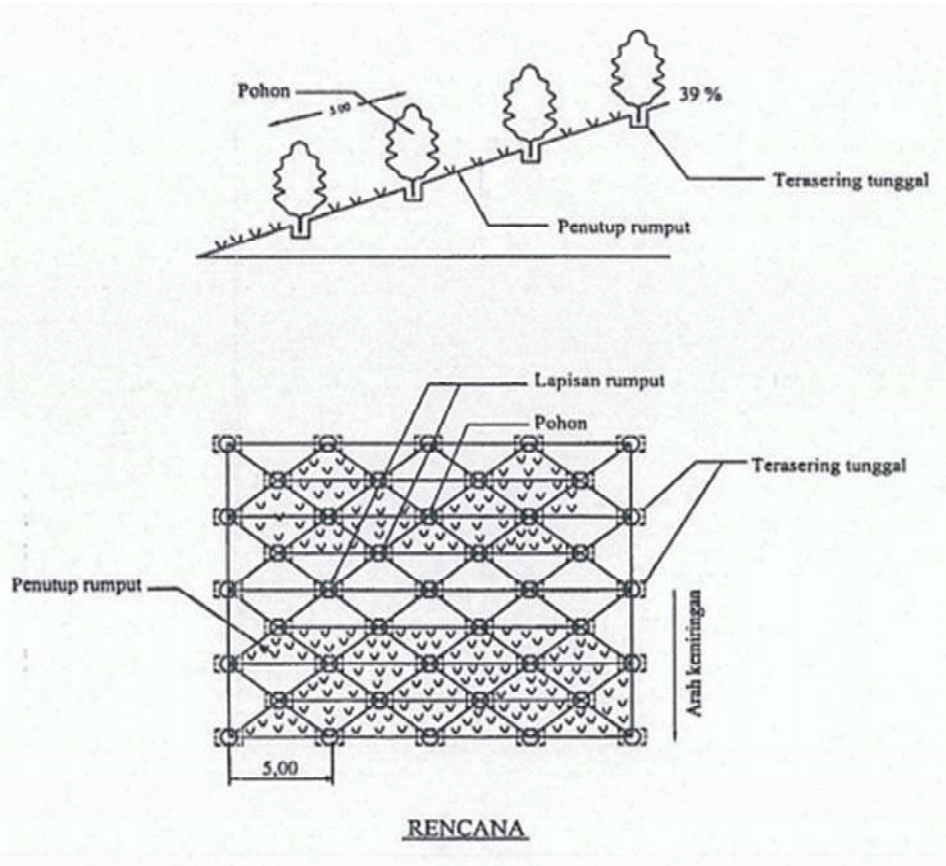
PENANGANAN SECARA VEGETATIF

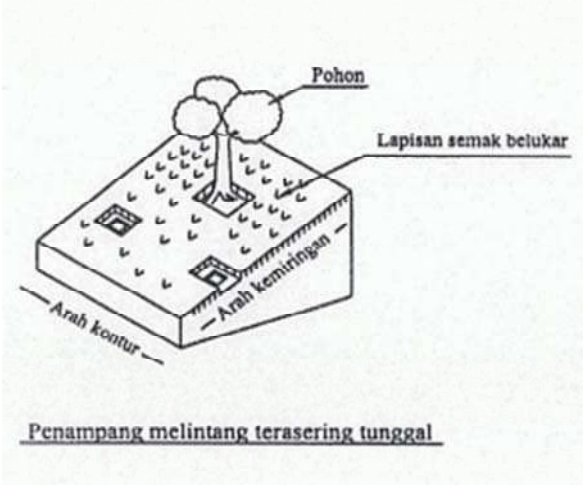
- Pengelolaan tanah dan vegetatif



Zonasi Kemiringan dan Penanganan Erosi

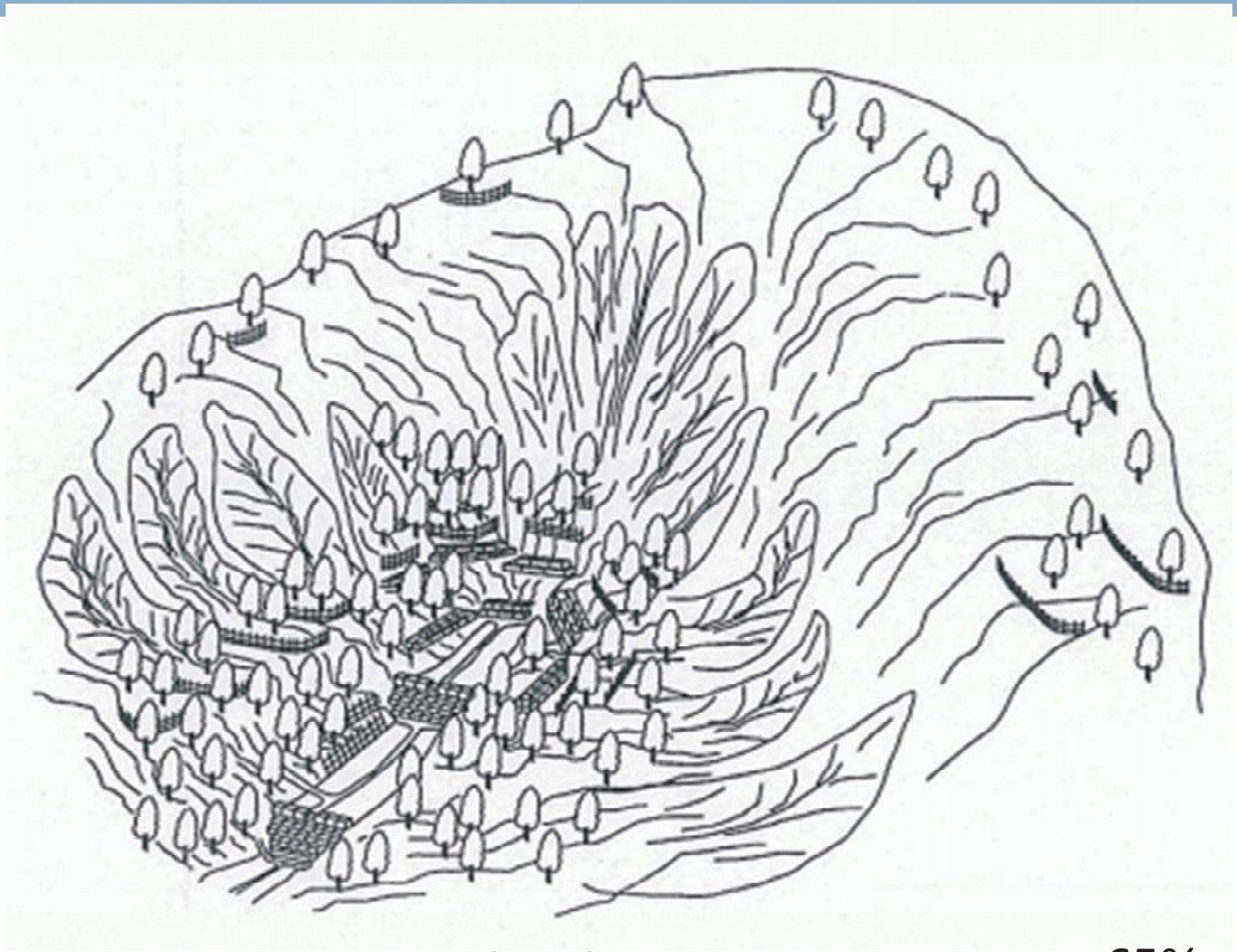
PENANGANAN SECARA VEGETATIF





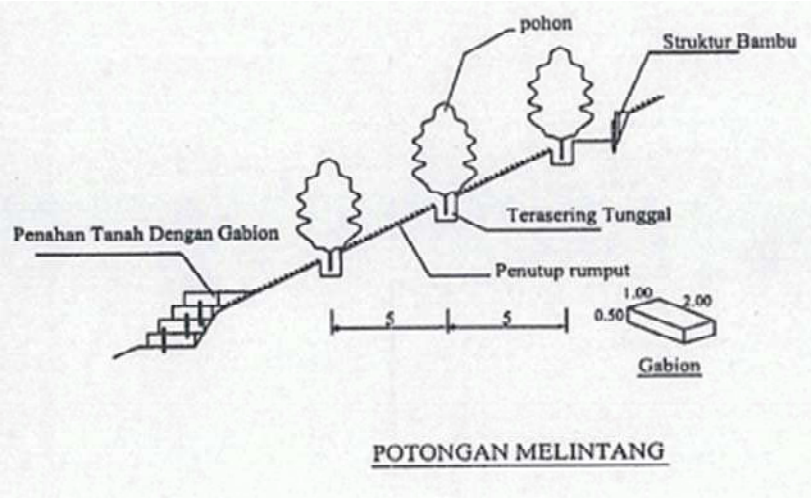
Penaanganan Erosi Pada Lahan Dengan Kemiringan < 40%

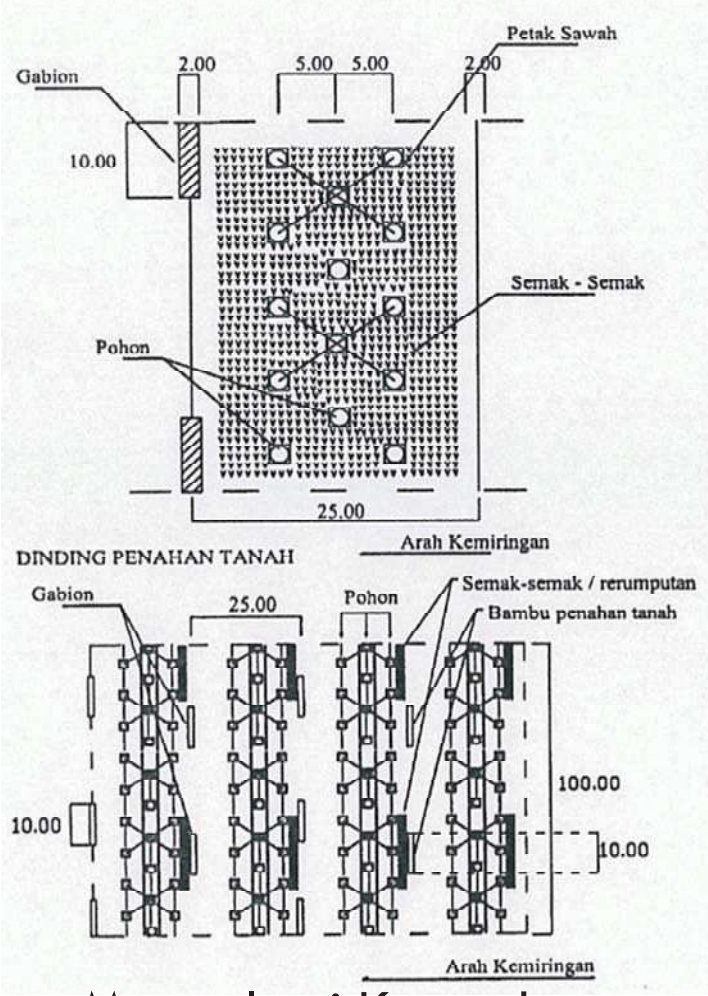
PENANGANAN SECARA VEGETATIF



Penanganan Erosi Pada Lahan Dengan Kemiringan > 65%

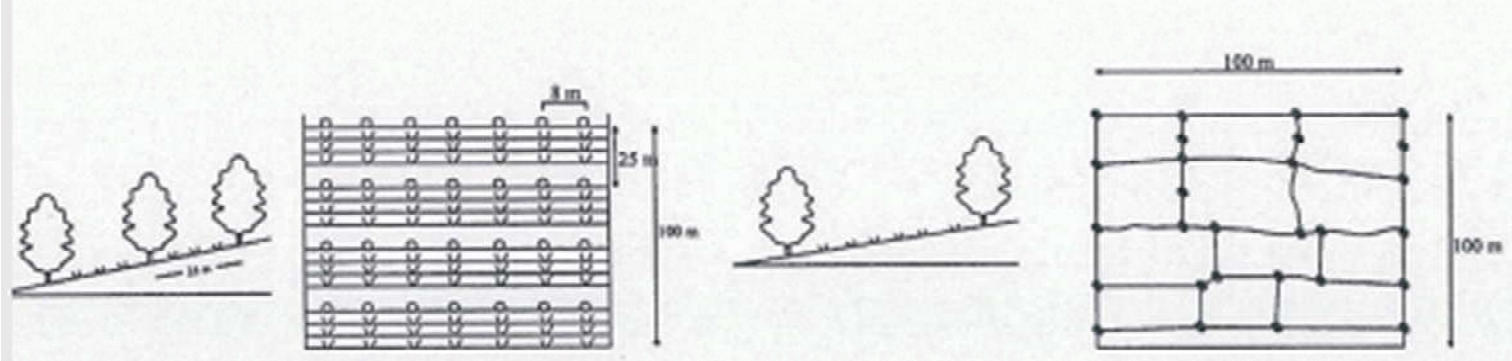
PENANGANAN SECARA VEGETATIF



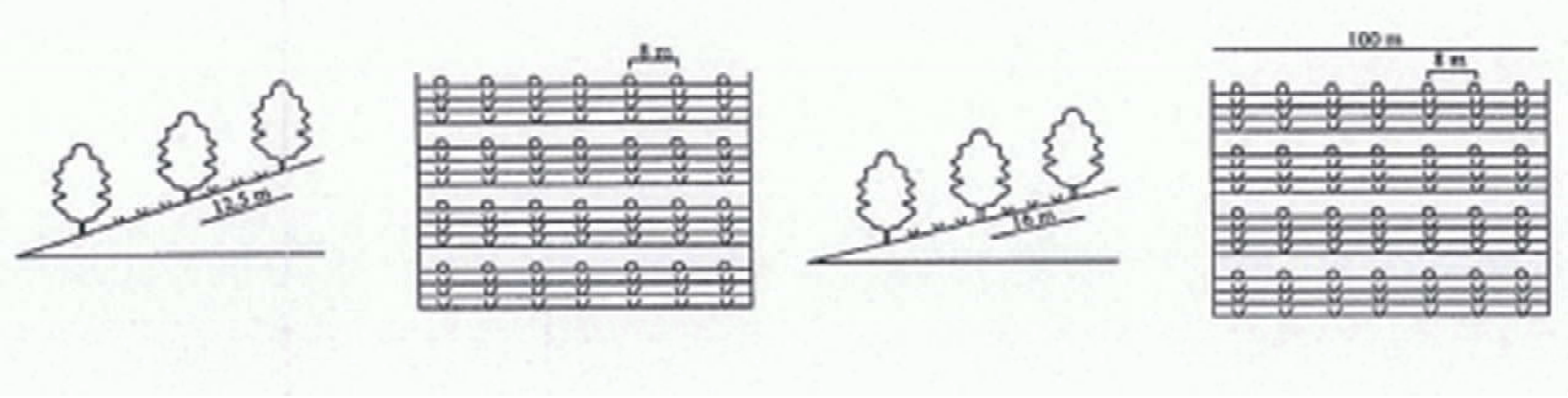


Penanganan Erosi Pada Lahan Hutan Yang Mengalami Kerusakan

PENANGANAN SECARA VEGETATIF

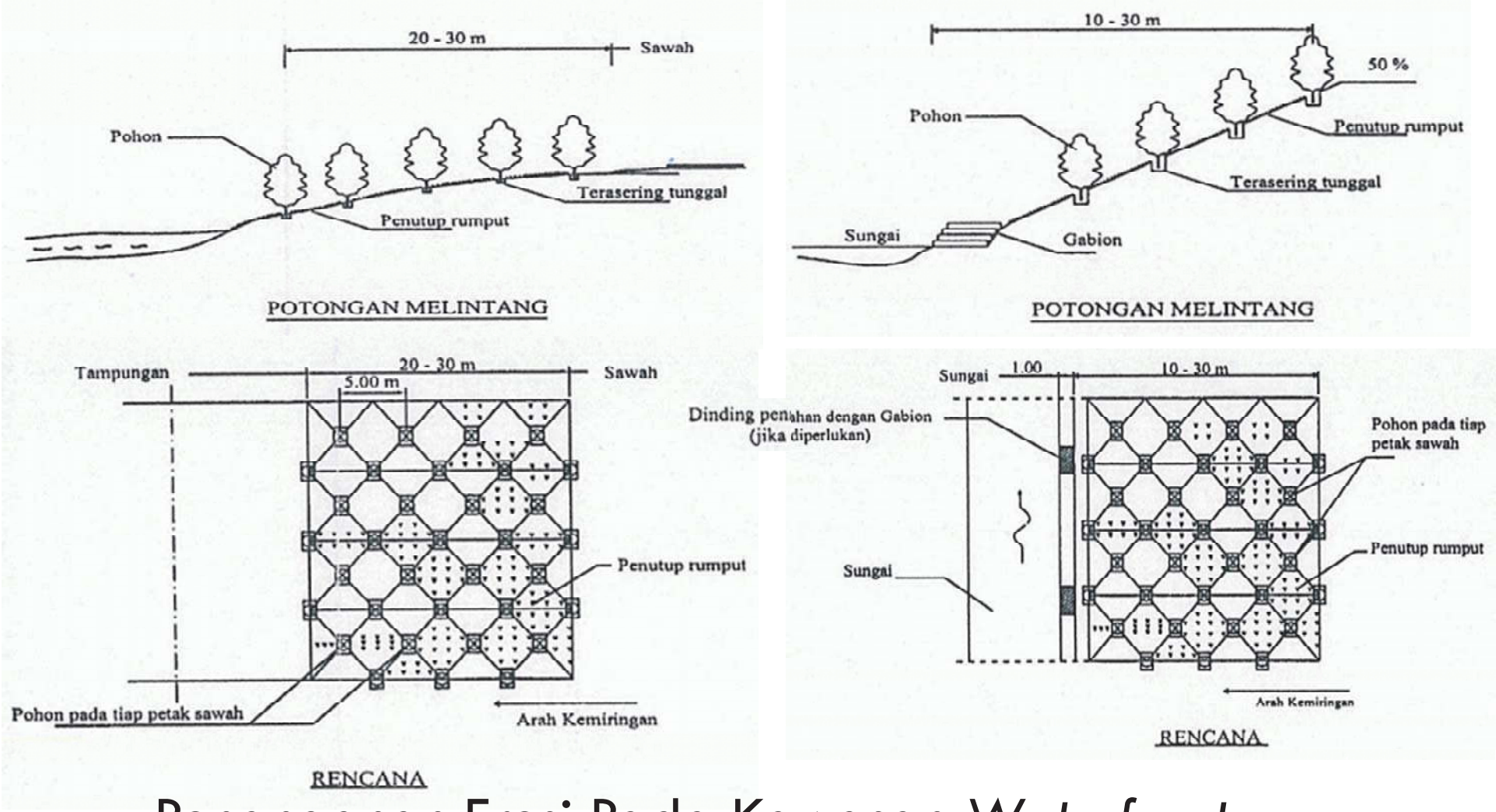


Penanganan Erosi Pada Lahan Pertanian Kemiringan < 8 %



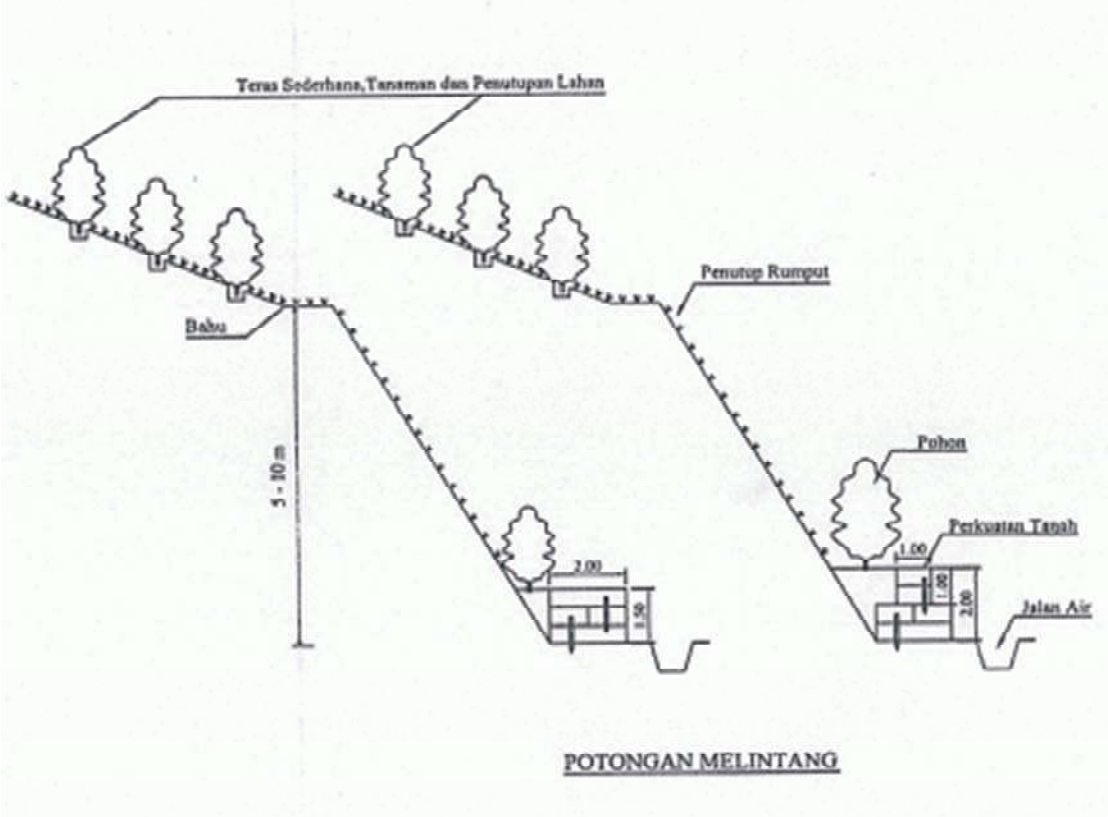
Penanganan Erosi Pada Lahan Pertanian Kemiringan 15 - 25%

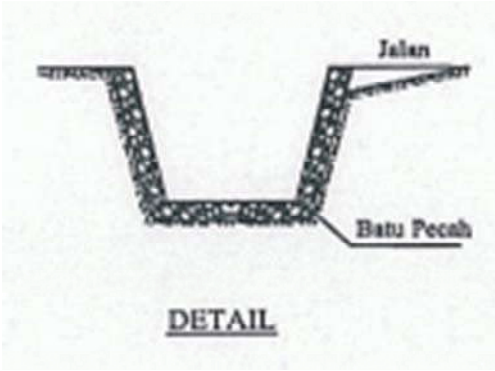
PENANGANAN SECARA VEGETATIF



Penanganan Erosi Pada Kawasan *Waterfront*

PENANGANAN SECARA VEGETATIF





Penanganan Erosi Pada Tebing di Tepi Jalan

PENANGANAN SECARA SOSIAL

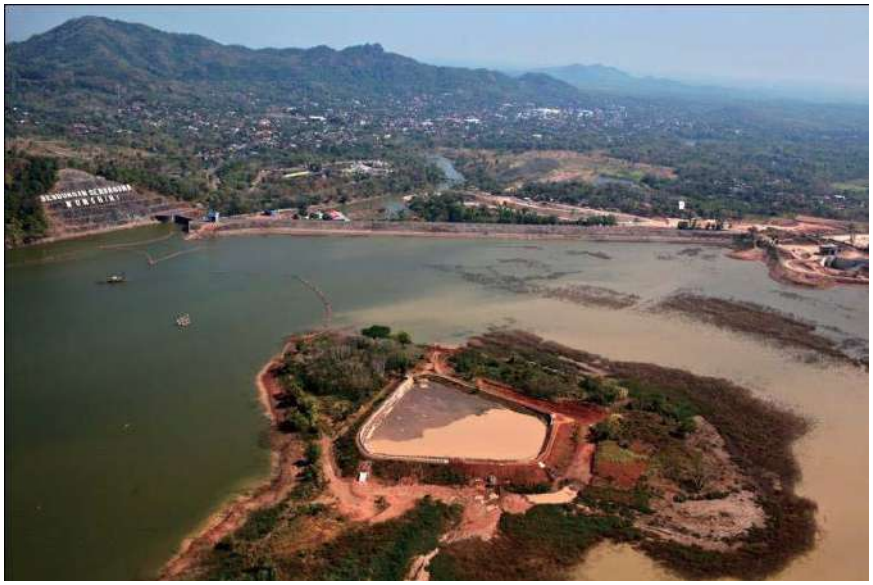
- Kegiatan penanganan sedimentasi waduk secara sosial :
  1. Penyebar luasan informasi tentang peraturan dan perundang-undangan
  2. Perkuatan penerapan peraturan dan perundang-undangan
  3. Penyelenggaraan pendidikan/pelatihan
  4. Peningkatan/perbaikan kebiasaan masyarakat
  5. Pemberian hadiah bagi masyarakat yang berpera aktif
  6. Perkuatan koordinasi dan kolaborasi antara instansi
  7. Pemantauan dan Evaluasi

PEMANTAUAN *(MONITORING)* SEDIMENTASI WADUK

- Aspek penting yang harus dipantau adalah aspek tataguna lahan didaerah tangkapan serta aspek perubahan dasar tampungan waduk.

- Kegiatan pemantauan harus dilakukan dengan teratur sehingga memudahkan dalam analisis dan evaluasi yang kemudian dapat digunakan untuk menentukan langkah penanganan sedimentasi.

BENDUNGAN DENGAN SEDIMENTASI



Bendungan Wonogiri

Bendungan Bili-Bili

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
DIREKTORAT BINA OPERASI DAN PEMELIHARAN

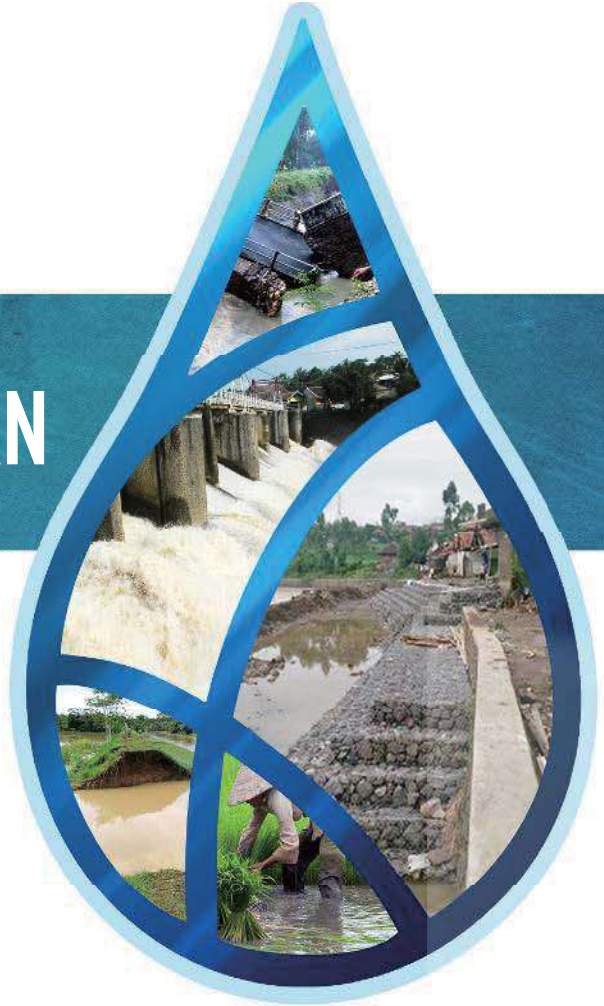
Thank You

CINOP
MELAKSANAKAN KEWAJIBAN UNTUK MEMENUHI KEBUTUHAN AIR MASYARAKAT

Bekerja Keras – Bergerak Cepat – Bertindak Tepat
BERANI – KUAT – BERJIWA SENI

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
DIREKTORAT BINA OPERASI DAN PEMELIHARAAN

OPERASI DAN PEMELIHARAAN BENDUNGAN

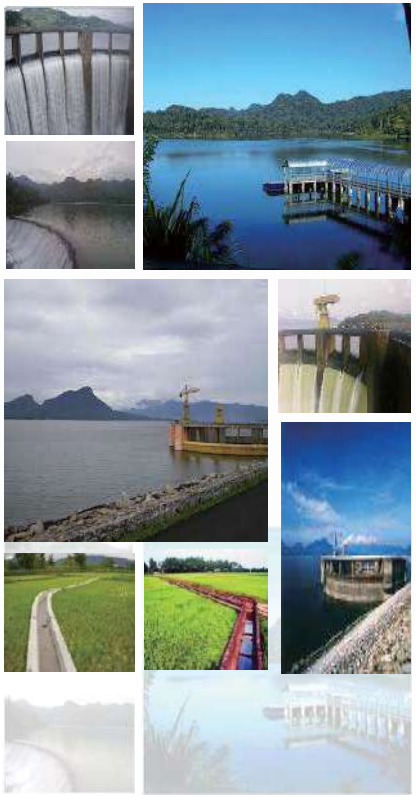


Manado, 15 Agustus 2018

SUBDIT O&P BENDUNGAN DAN DANAU

A6-3-No.005-77

Outline:



I. DASAR HUKUM

II. LATAR BELAKANG

III. SEBARAN BENDUNGAN DI INDONESIA

IV. PERATURAN DAN PEDOMAN

V. PENGELOLAAN BENDUNGAN

VI. PELAKSANAAN O&P BENDUNGAN

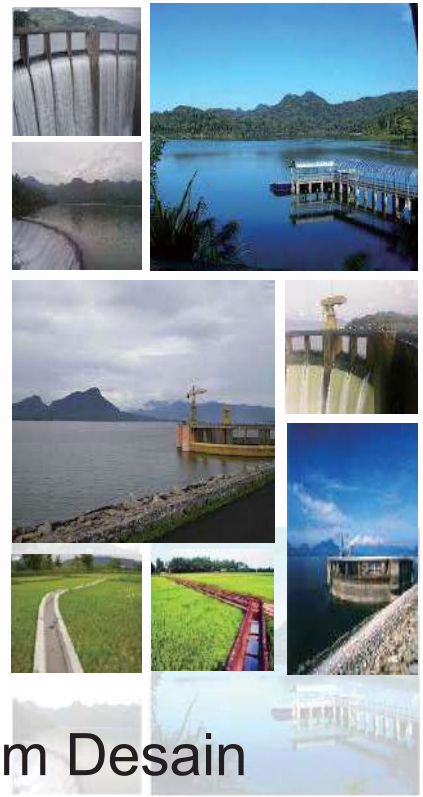
VII. O&P BENDUNGAN TERPADU

A6-3-No.005-78

1 DASAR HUKUM

A6-3-No.005-79

DASAR HUKUM



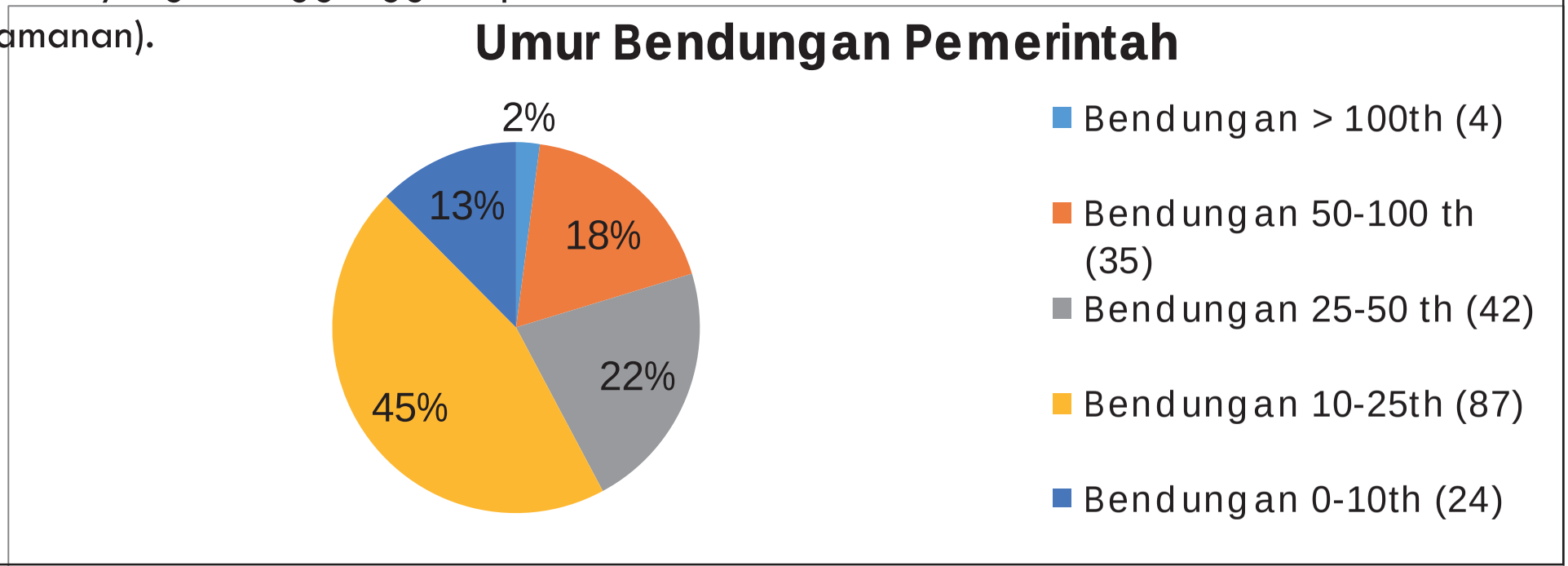
- UU No. 11 Tahun 1974, Pengairan
- PP No. 22 Tahun 1982, Tata Pengaturan Air
- Permen PUPR No. 06/PRT/2015, Eksploitasi dan Pemeliharaan SDA dan Bangunan Pengairan
- Permen PUPR No. 09/PRT/2015, Penggunaan SDA
- Permen PUPR No. 27/PRT/2015, Bendungan
- Keputusan Dirjen SDA/Ketua KKB No.05/KPTS/2003, Pedoman Kajian Keamanan Bendungan, Kriteria Umum Desain Bendungan, Inspeksi dan Evaluasi Keamanan Bendungan
- Keputusan Dirjen SDA No.199/KPTS/2003, Pedoman Operasi, Pemeliharaan dan Pengamatan Bendungan
- SE Dirjen SDA No. 01/SE/D/2016,Tata Cara Perhitungan AKNOP Bendungan
- Draft Pedoman Operasi & Pemeliharaan Bendungan

A6-3-No.005-80

2 LATAR BELAKANG

LATAR BELAKANG

- Jumlah Bendungan di Indonesia 224, 192 milik Pemerintah/Kementerian PUPR (6,999 milyar m3) dan 32 milik BUMN/Swasta *Des 17*
- Bendungan Indonesia umumnya sudah tua mempunyai masalah **fungsi** dan **keamanan** (penumpukan sedimen di waduk yang mengganggu operasi dan keamanan).
- Sejarah pembangunan bendungan di Indonesia dimulai sekitar tahun 1910-1917 dengan dibangunnya bendungan Nglangon dan bendungan Tempuran di Jawa Tengah, bendungan Prijetan (Jawa Timur) dan bendungan PLTA Cileunca (Jawa Barat).



ISU-ISU PENGELOLAAN BENDUNGAN

- Umur bendungan banyak > 50 tahun;
- Kondisi dan fungsi menurun;
- Izin operasi bendungan
- Alokasi anggaran O & P belum memadai;
- O & P Bendungan belum dijadikan prioritas;
- SDM/Unit Pengelola belum memadai (kuantitas/kualitas);
- Rencana Tindak Darurat (RTD) belum semua bendungan;
- Pelaksanaan Operasi dan Pengamatan tidak sesuai pedoman/manual dan pola;
- Pedoman/Manual O & P umumnya tidak tersedia;
- Pemeriksaan, pemantauan & evaluasi kondisi bendungan tidak dilakukan sebagaimana mestinya.

A6-3-No.005-83

BENDUNGAN

Bangunan yang berupa urugan tanah, urugan batu, beton, dan/atau pasangan batu yang dibuat untuk menahan air, limbah atau bahan cair lainnya sehingga terbentuk tampungan/waduk

WADUK

Wadah buatan untuk menampung air, limbah atau bahan cair lainnya yang terbentuk sebagai akibat dibangunnya bendungan

(Pasal 1, Permen PUPR No. 27/2015)

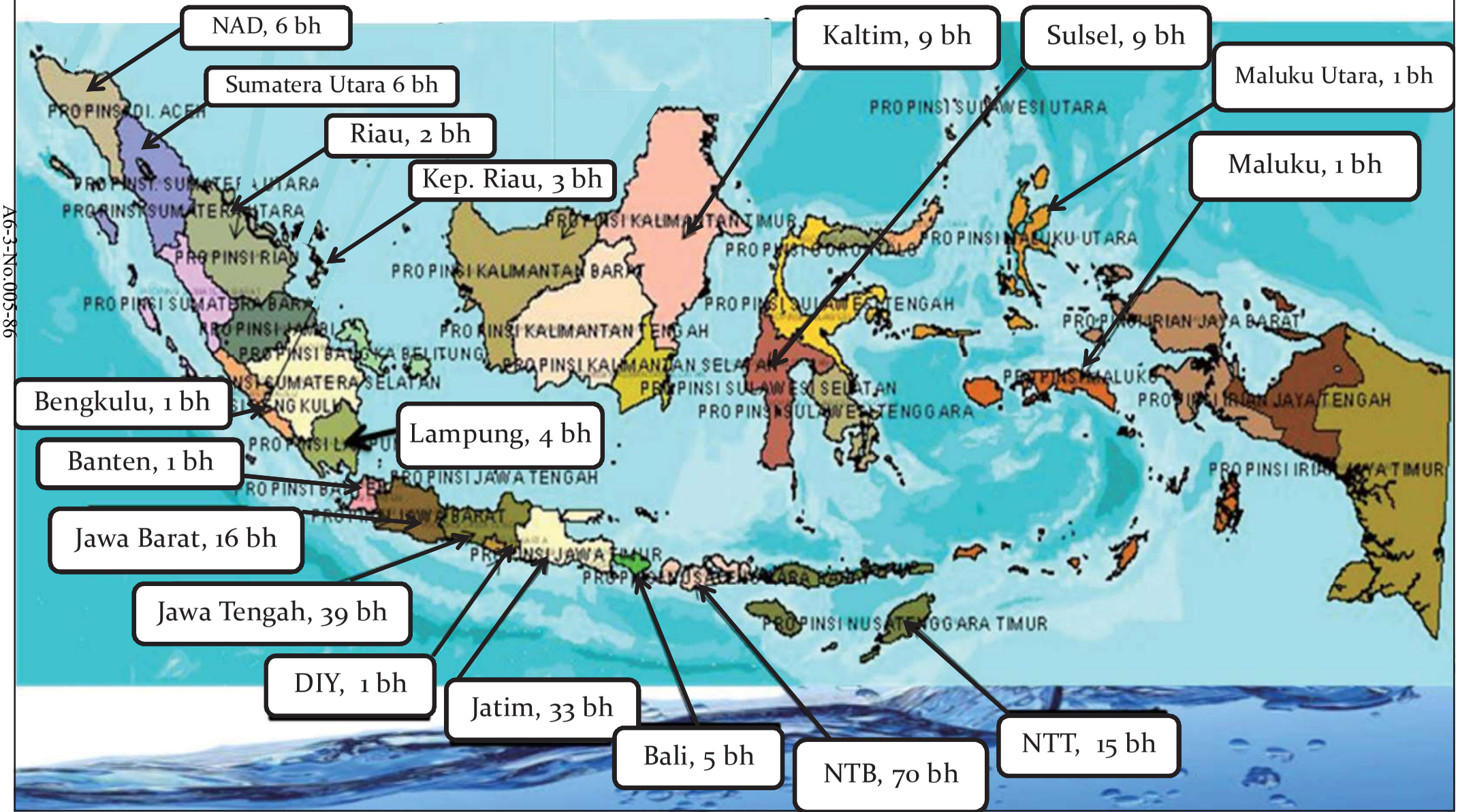
3 SEBARAN BENDUNGAN DI INDONESIA

A6-3-No.005-85

SEBARAN BENDUNGAN INDONESIA

(Kriteria PERMEN PUPR No 27/PRT/M/2015)

TOTAL: 224 bendungan tersebar di 13 Provinsi

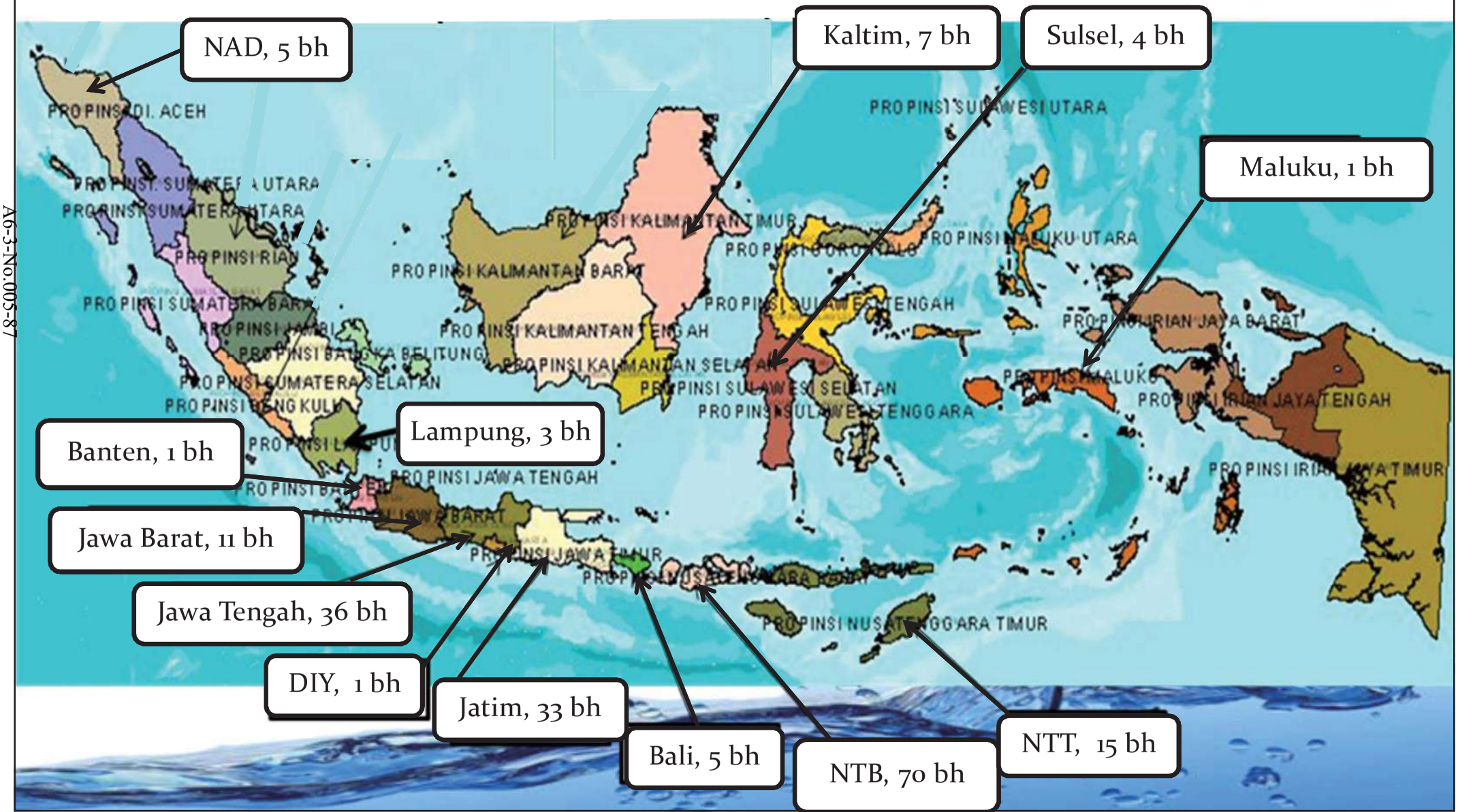


A6-3-No.005-86

Sebaran Bendungan Milik Kementerian PUPR

(Kriteria PERMEN PUPR No. 27/PRT/M/2015)

TOTAL: 192 bendungan tersebar di 13 Provinsi



4 PERATURAN DAN PEDOMAN

A6-3-No.005-88

PERATURAN DAN PEDOMAN (1)

No	Peraturan/Pedoman	Keputusan Dirjen SDA No:
1.	Penyiapan Rencana Tindak Darurat	94/KPTS/A/1998
2.	Tata Tertib Sidang Komisi Keamanan Bendungan	01/KPTS/2002
3.	Registrasi dan Inventarisasi Bendungan	02/KPTS/2002
4.	Tata Cara untuk Persetujuan Pembangunan dan Penghapusan Fungsi Bendungan	04/KPTS/2002
5.	Pengisian Waduk	Oktober 2002
6.	Inspeksi dan Evaluasi Keamanan Bendungan	05/KPTS/2003
7.	Kajian Keamanan Bendungan	05/KPTS/2003
8.	Kriteria Umum Desain Bendungan	05/KPTS/2003
9.	Pedoman OP dan PB	
	a. Bagian 1 : Umum	199/KPTS/D/2003
	b. Bagian 2 : Pengelolaan Operasi dan Pemeliharaan	199/KPTS/D/2003
	c. Bagian 3 : Sistem Informasi dan Pemantauan	199/KPTS/D/2003
	d. Bagian 4 : Instrumentasi Keamanan Untuk Peralatan Hidromekanikal	199/KPTS/D/2003
	e. Bagian 5 : Operasi & Pemeliharaan Peralatan Hidromekanikal dan Elektrik	199/KPTS/D/2003

PERATURAN DAN PEDOMAN (2)

No	Peraturan/Pedoman	Keputusan Dirjen SDA No:
10.	Pengelolaan Sedimentasi Waduk	November 2004
11.	Bendungan Limbah Tambang	November 2004
12.	Pelaksanaan Konstruksi Bendungan Urugan	November 2004
13.	Manual Inspeksi Visual Bendungan Urugan	November 2004
14.	Pengendalian Rembesan pada Bendungan Urugan	Desember 2005
15.	Grouting untuk Bendungan	Desember 2005
16.	Pembuatan Dinding Halang (Cut-Off Wall) pada Bendungan Urugan	Desember 2005
17.	Pembangunan Bendungan Uruganpada Pondasi Tanah Lunak	04/KPTS/D/2007
18.	Analisa Dinamis Bendungan Urugan	27/KPTS/D/2008
29.	Analisa Dinamik Bendungan Beton Gaya Berat	38/KPTS/D/2009
20.	Survey dan Monitoring Sedimentasi Waduk	39/KPTS/D/2009
21.	Klasifikasi Bahaya Bendungan	257/KPTS/D/2011
22.	Perencanaan dan Pelaksanaan Bendungan Beton Padat Gilas	305/KPTS/D/2011

A6-3-No.005-90

PERATURAN DAN PEDOMAN (3)

No	Peraturan/Pedoman	Keputusan No:
23.	Desain dan Konstruksi Bendungan Urugan Batu Membran Beton (CFRD)	304/KPTS/D/2011
24.	Pedoman Penilaian Risiko Bendungan	303/KPTS/D/2011
25.	Perencanaan dan Pelaksanaan Konstruksi Terowongan untuk Bendungan	325/KPTS/D/2011
26.	Peta Isohit PMP Indonesia	153/KPTS/D/2013
27.	Perhitungan Aknop Bendungan	01/KPTS/D/2016

LEGALISASI PENYUSUNAN PERATURAN (2018)

- SE Dirjen SDA tentang Pedoman Rencana Tindak Darurat (Naskah Akademis Thn 2014), Pedoman lama SK Dirjen SDA 1998
- SE Dirjen SDA tentang Pedoman Inventarisasi dan Registrasi Bendungan (Naskah Akademis Thn 2014), Pedoman lama SK Dirjen SDA Thn 2002
- SE Dirjen SDA tentang Pedoman Pengisian Awal Waduk (Naskah Akademis Thn 2014), Pedoman lama SK Dirjen SDA Thn 2002
- SE Dirjen SDA tentang Pedoman OP Bendungan (Naskah Akademis Thn 2010/2011), Pedoman lama SK Dirjen SDA 2003
- SE Dirjen SDA tentang Pedoman Penilaian Kinerja Bendungan (Naskah Akademis Thn 2016)
- SE Dirjen SDA tentang Pedoman Pembentukan UPB (Naskah Akademis Thn 2017)

5 PENGELOLAAN BENDUNGAN

A6-3-No.005-93

BENDUNGAN

MANFAAT DAN POTENSI RESIKO

Bendungan beserta waduknya mempunyai fungsi dan manfaat sangat besar untuk memenuhi berbagai kebutuhan bagi kehidupan dan penghidupan manusia.

Bendungan merupakan suatu infrastruktur dan aset yang sangat penting yang perlu dijaga keamanannya. Selain memberikan manfaat besar, bendungan juga mengandung potensi resiko terjadinya bencana apabila terjadi kegagalan bendungan. (yang disebabkan oleh faktor eksternal dan faktor internal)

Terjadinya kegagalan suatu bendungan, selain disebabkan oleh kejadian alam yang luar biasa (banjir bandang, gempa bumi, tanah longsor), secara tidak langsung juga disebabkan oleh kondisi fisik bangunan yang sudah menurun, kerusakan internal, tidak berfungsinya prasarana bangunan, karena faktor keterbatasan dalam pengelolaan.

PERLU PEMBINAAN DALAM PEMBANGUNAN DAN PENGELOLAAN BENDUNGAN

PENGELOLAAN BENDUNGAN

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
Jl. Pattimura No. 20 Kebayoran Baru, Jakarta Selatan, 12110 Telp. : (021) 7396616 – Fax (021) 7208285

No : PR. 04.01 - DA /70 Jakarta, 25 Januari 2018
Sifat : Segera
Lampiran : 1 (satu) berkas
Hal : **Pengelolaan Bendungan Terkait Perlindungan dan Pelestarian Guna Keberlanjutan Fungsi dan Keamanan**

Kepada Yth.
(daftar terlampir)
di-
Tempat

Sehubungan dengan telah dilaksanakannya audit kinerja terkait bendungan oleh BPK-RI, bersama ini para Kepala BBWS/BWS sebagai Pengelola Bendungan diminta melaksanakan hal-hal sebagai berikut :

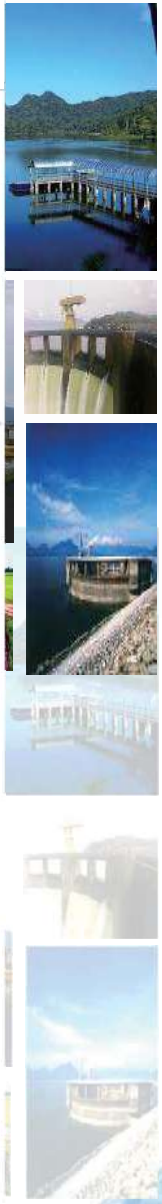
1. Guna menjaga kelangsungan fungsi bendungan, setiap bendungan harus dilengkapi dengan rencana pengelolaan bendungan yang memuat konservasi sumber daya air sebagai upaya menjaga kelangsungan daya tampung waduk.
2. Sesuai Pasal 91 Permen PUPR No. 27 Tahun 2015 tentang Bendungan menyatakan bahwa "pelaksanaan operasi bendungan wajib dilakukan berdasarkan izin operasi bendungan yang dikeluarkan oleh Menteri". Untuk itu diminta agar segera melakukan pengurusan izin operasi bagi bendungan yang belum memilikinya.
3. Untuk mengoptimalkan Pelaksanaan Operasi dan Pemeliharaan bendungan, diminta agar setiap bendungan dilengkapi dengan perencanaan dan konsep penanganan operasi dan pemeliharaan yang komprehensif, agar pemanfaatan infrastruktur dan pembiayaan operasi dan pemeliharaan lebih efektif untuk menjaga fungsi terkait kualitas dan kuantitas waduk serta keamanan bendungan.
4. Menindaklanjuti pemanfaatan bendungan antara lain untuk irigasi, air baku, PLTA/PLTM maupun pemanfaatan lainnya, diminta agar segera diprogramkan pemanfaatannya dengan berkordinasi bersama Pemerintah Daerah maupun instansi terkait lainnya.
5. Menindaklanjuti hasil pemantauan atas kondisi bendungan dan mengambil langkah penanganannya secara tepat.
6. Mengoptimalkan pelaksanaan tugas pemantauan daerah tangkapan air sesuai dengan Permen Nomor 27 Tahun 2015 tentang Bendungan, serta berkoordinasi dengan pihak terkait dalam rangka perlindungan dan pelestarian Waduk.
7. Memaksimalkan tugas UPB dalam memantau laju sedimentasi secara berkala, setelah itu segera menindaklanjuti hasil pemantauan sedimentasi bendungan dan melakukan koordinasi dengan instansi terkait lainnya.

Demikian disampaikan untuk dilaksanakan, atas perhatiannya diucapkan terima kasih.

Direktur Jenderal Sumber Daya Air

Ir. Imam Santoso, M.Sc
NIP. 19580308 198410 1002

Tembusan Kepada Yth :
1. Bapak Menteri Pekerjaan Umum dan Perumahan Rakyat; (sebagai laporan)
2. Ibu Sekjen Kementerian Pekerjaan Umum dan Perumahan Rakyat;
3. Direktur Bina Operasi dan Pemeliharaan;
4. Kepala Pusat Bendungan;
5. Kepala Pusat Air Tanah Air Baku.



A6-3-No.005-95

	BENDUNGAN	1.Penyusunan Rencana Pengelola Bendungan (Ps.42,45-50), meliputi Pedoman OP Bendungan (Ps. 46) dan Pola Operasi Waduk (Ps. 47)
		2. Pembentukan UPB (Unit Pengelola Bendungan) (Ps.42,52,77,78,79,81)
		3. Penyusunan/Pemutakhiran Rencana Tindak Darurat/RTD (Ps. 42,53-60)
		4. Izin Operasi (Ps. 91-94)
		5. Pelaksanaan OP Bendungan **(Ps. 76,84-88,90-91,95-98)**
		6. Pemantauan, Pemeriksaan dan Evaluasi kondisi bendungan (Ps. 84,89,95,114,157-159)
		7. Inspeksi (tahunan, besar, khusus) (Ps. 147-149)
		8. Pelatihan OP untuk tingkat pelaksana

A6-3-No.005-96

TAHAPAN

PEMBANGUNAN / PENGELOLAAN BENDUNGAN

A6-3-No.005-97

PENGELOLAAN BENDUNGAN

TUJUAN PENGELOLAAN BENDUNGAN
(Permen PUPR No.27/Th.2015)

Keamanan Bendungan

Efektifitas & Efisiensi Pemanfaatan Air

Kelestarian Fungsi & Manfaat Bendungan Beserta Waduknya

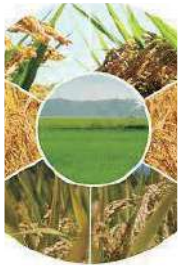
ISU UTAMA PENGELOLAAN BENDUNGAN

Usia Bendungan

(44% usia tua>25 thn)

Perubahan Iklim Global

(perubahan &peningkatan curah hujan)



Organisasi & Biaya OP

A6-3-No.005-98

U P B

EVALUASI

Terobosan : Pengelolaan Bendungan/Embung yang berbasis peran serta masyaratat secara mandiri

- Perlu tenaga tetap di UPB yang sesuai baik secara kalitatif maupun kuantitatif untuk menjalankan tusi pengelolaan bendungan
- Perlu evaluasi/screening kecukupan sarpras(kantor, sekretariat); personel; dan alokasi dana
- Peningkatan kuallitas SDM pengelola bendungan (sertifikasi, bimbingan teknis)

A6-3-No.005-99

PENYUSUNAN RENCANA PENGELOLAAN

Rencana Pengelolaan Bendungan ditujukan sebagai acuan dalam pelaksanaan operasi & pemeliharaan bendungan beserta waduknya, terdiri dari :

1) **Rencana**
   - Konservasi sumber daya air pada waduk;
   - Pendayagunaan waduk;
   - Pengendalian daya rusak air melalui pengendalian bendungan beserta waduknya; dan diselaraskan dengan system peringatan dini di wilayah sungai yang bersangkutan

2) **Pedoman Operasi & Pemeliharaan;**
   - Tata cara pengoperasian fasilitas bendungan dan pemeliharaan bendungan beserta waduknya.;
   - Ditinjau dan dievaluasi paling sedikit 1 (satu) kali dalam waktu 5 (lima) tahun.
   - Hasil peninjauan dan evaluasi , menjadi dasar penyempurnaan pedoman operasi dan pemeliharaan bendungan beserta waduknya.

A6-3-No.005-100

3) Pola Operasi Waduk (POW)

- Pola operasi waduk, :

a. Lengkung batas operasi normal bawah yg disusun berdasar data hidrologi tahun kering;

b. Lengkung batas operasi normal atas yang disusun berdasar data hidrologi tahun basah.

c. Memuat tata cara pengeluaran air dari waduk

d. Disusun oleh Pembangun/Pengelola bendungan.

e. Bagi bendungan seri (*cascade*), penyusunan POW dengan melibatkan pengelola bendungan lain yang terletak dalam satu sungai dengan bendungan yang bersangkutan.

f. Ditetapkan oleh Pengelola bendungan untuk jangka waktu 5 th.

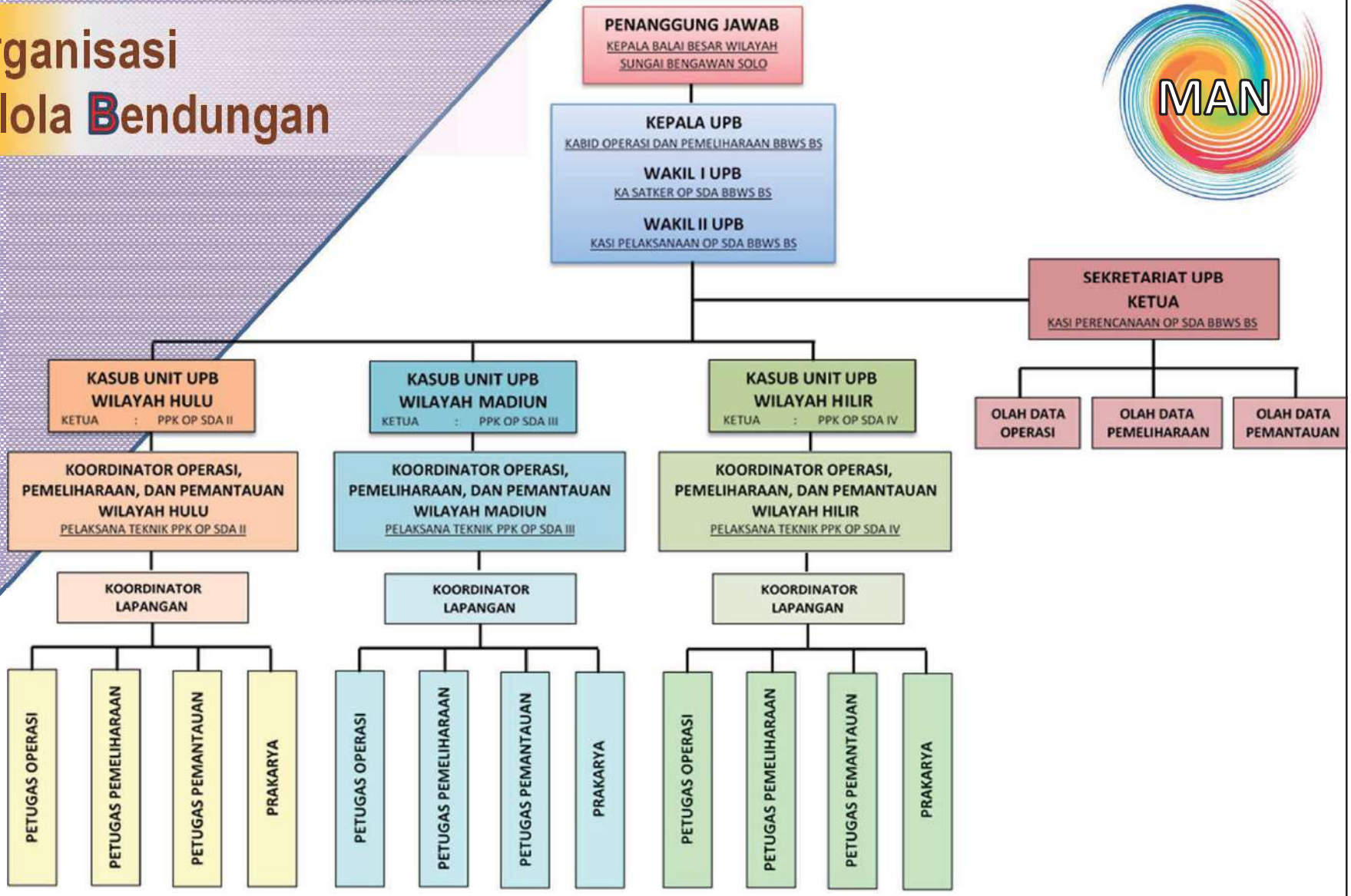
g. Berdasarkan POW butir (f), Pengelola bendungan menyusun rencana tahunan operasi waduk (ROTW).

h. ROTW butir (g), disusun oleh Pengelola bendungan dengan memperoleh masukan teknis dari pengelola sumber daya air pada wilayah sungai yang bersangkutan dan instansi terkait.

4) Perubahan atau Rehabilitasi bendungan

5) Penghapusan fungsi bendungan.

Struktur Organisasi Unit Pengelola Bendungan



A6-3-No.005-102

UNIT PENGELOLA BENDUNGAN (UPB)

- DISETIAP BENDUNGAN ADA PETUGAS OPERASI DAN PEMELIHARAAN YANG MELAKSANAKAN KEGIATAN OPERASI, PEMELIHARAAN DAN PEMANTAUAN SERTA UNIT KEAMANAN YANG DIKOORDINIR OLEH SEORANG KOORDINATOR
- APABILA DIDALAM WS ADA OPERATOR BENDUNGAN (BUMN, BUMD, BU), MASING MASING OPERATOR WAJIB MEMBENTUK UPB
- DALAM PENYUSUNAN DAN PELAKSANAAN ROTW untuk OPERASI WADUK BERKOORDINASI DENGAN UPB BALAI

UNIT PENGELOLA BENDUNGAN
(Ps 81 Permen PUPR No.27/2015)

- UPB SEBAGAIMANA DIATUR PADA Ps 77, 78, dan 79 MEMPUNYAI TUGAS MELAKSANAKAN PENGELOLAN BENDUNGAN BESERTA WADUKNYA
- UPB DIPIMPIN OLEH KEPALA UNIT PENGELOLA BENDUNGAN
- KEPALA UPB HARUS MEMENUHI PERSYARATAN :

1. MEMILIKI SERTIFIKAT KEAHLIAN BIDANG BENDUNGAN YANG DIKELUARKAN OLEH LEMBAGA YANG BERWENANG SESUAI DENGAN KETENTUAN PER UU
2. MEMILIKI KOMPETENSI DALAM PENGELOLAAN BENDUNGAN BESERTA WADUKNYA

- PERSYARATAN DAN PROSEDUR PEMBENTUKAN UPB DILAKUKAN SESUAI DENGAN PEDOMAN YANG DITETAPKAN OLEH MENTERI

UNIT PENGELOLA BENDUNGAN (UPB)

- PENANGGUNG JAWAB UPB ADALAH KEPALA BALAI (Permen PUPR nomor : 20/ PRT/ M/ 2016)
- KEPALA UPB melekat pada struksur organisasi Balai yaitu untuk BBWS dijabat oleh KEPALA BIDANG OP dan untuk BWS dijabat oleh KEPALA SEKSI OP / KEPALA SEKSI PERENCANAAN DAN OP (Permen PUPR nomor : 20/ PRT/ M/ 2016)
- KEPALA SEKRETARIAT UPB untuk BBWS dijabat oleh KEPALA SEKSI PERENCANAAN OP dan untuk BWS dijabat oleh PPK OP SDA 1 yang dibantu petugas bidang program, evaluasi, dan pelaporan untuk kegiatan operasi, pemeliharaan, dan pemantauan

UNIT PENGELOLA BENDUNGAN (UPB)

- WAKIL KEPALA UPB I untuk BBWS dan BWS dijabat oleh KEPALA SATUAN KERJA OP dengan pertimbangan yang bersangkutan sebagai penanngungjawab dana untuk kegiatan UPB
- WAKIL KEPALA UPB II untuk BBWS dijabat oleh KEPALA SEKSI PELAKSANAAN OP
- WAKIL KEPALA SEKRETARIAT UPB untuk BBWS dijabat oleh PPK OP SDA1 dengan pertimbangan yang bersangkutan sebagai penanngungjawab dana wajib balai UPB sedangkan untuk BWS dijabat oleh PETUGAS yang kompeten dibidang bendungan
- KEPALA SUB UPB dijabat oleh PPK OP SDA sebagai penanggung jawab anggaran kegiatan Operasi dan Pemeliharaan
- WAKIL KEPALA SUB UPB dijabat oleh PETUGAS yang kompeten dibidang bendungan.

TUGAS UNIT PENGELOLA BENDUNGAN (UPB)

MELAKSANAKAN PENGELOLAAN BENDUNGAN BESERTA WADUKNYA MELIPUTI :

1. MENYUSUN RENSTRA OP UNTUK 5 TAHUNANGGARAN (PEMERIKSAAN DAN OPP RUTIN, PEMERIKSAAN DAN OPP BERKALA, INSPEKSI BESAR, SPECIAL STUDY)
2. MENYUSUN CANOP SETIAP TAHUN ANGGARAN (DETAIL DARI RENSTRA)
3. MENYUSUN ROTW
4. MELAKSANAKAN OPERASI, PEMELIHARAAN, DAN PEMANTAUAN (OPP) SERTA PENGAMANAN
5. PEMUTAKHIRAN RTD (5 TH)
6. PEMUTAKHIRAN PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (5 TH)
7. PEMUTAKHIRAN POLA OPERASI WADUK (5 TH)
8. MENYUSUN SOP UNTUK UPB DAN PETUGAS OPP

DOKUMEN YANG HARUS DIMILIKI OLEH UPB

1. IZIN PENGGUNAAN SDA (Ps 10)
2. PERSETUJUAN PRINSIP PEMBANGUNAN BENDUNGAN (Ps 16) 5 TH, 1X
3. PERSETUJUAN DESAIN BENDUNGAN (Ps 24) **
4. DOKUMEN STUDI PENGADAAN TANAH DAN STUDI PEMUKIMAN KEMBALI (Ps 26)
5. IZIN PELAKSANAAN KONSTRUKSI BENDUNGAN (Ps 30) ** UNTUK 3 TH
6. RENCANA PENGELOLAAN BENDUNGAN YANG BERISIKAN
7. PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (TERMASUK AKNOP) DILENGKAPI DENGAN
8. POLA OPERASI WADUK (5 TH) (Ps 45, 46, 47)
9. RENCANA TINDAK DARURAT/ RTD (Ps 53)
10. IZIN PENGISIAN AWAL WADUK (Ps 64) **
11. AS BUILT DRAWING
12. DOKUMEN LAPORAN AKHIR PELAKSANAAN KONSTRUKSI (PS 90) **
13. IZIN OPERASI (PS 92) **
14. PENETAPAN STATUS PENGGUNAAN (PSP) >>> **BMN / ASET**

PENYUSUNAN/PEMUTAKHIRAN RENCANA TINDAK DARURAT/RTD (Ps. 42,53-60)

Penyusunan RTD adalah sebagai bentuk Kesiapsiagaan tindak darurat agar pengelola bendungan selalu siap menghadapi kondisi terburuk dari bendungan yang dikelolanya.

Langkah untuk memenuhi kesiapsiagaan tindak darurat adalah:

a. penyusunan **RTD**; b. penyiapan peralatan dan material untuk tindak darurat; c. pemutakhiran **RTD**; d. penyiapan personil untuk pelaksanaan tindak darurat; e. sosialisasi terhadap unsur masyarakat; dan f. sosialisasi terhadap pemerintah provinsi dan pemerintah kabupaten/kota.

Dalam menyusun rancangan **RTD**, pembangun bendungan memperoleh masukan teknis dari pengelola sumber daya air pada wilayah sungai dan unsur masyarakat yang terpengaruh terhadap potensi kegagalan bendungan.

Rancangan **RTD**, disampaikan kepada **unit pelaksana teknis bendungan** untuk memperoleh **saran teknis**.

Rancangan **RTD**, paling sedikit memuat tindakan:

a. pengamanan bendungan; dan

b. penyelamatan masyarakat serta lingkungan.

Rancangan **RTD**, harus dilengkapi dengan **analisis keruntuhan bendungan**.

IZIN OPERASI

(Ps. 91-94)

Pelaksanaan operasi bendungan wajib dilakukan berdasarkan **izin operasi bendungan** yang dikeluarkan oleh Menteri.

Izin operasi bendungan, diberikan berdasarkan permohonan yang diajukan oleh Pengelola bendungan.

Permohonan harus memenuhi persyaratan :

Persyaratan administratif meliputi dokumen:

a. permohonan izin operasi bendungan; b. identitas Pengelola bendungan; c. keputusan pembentukan unit pengelola bendungan; dan d. izin atau persyaratan lain sesuai dengan ketentuan peraturan perundang undangan.

Persyaratan teknis berupa:

a. data teknis bendungan; b. laporan pengisian awal waduk; c. laporan analisis perilaku bendungan; d. pedoman operasi dan pemeliharaan bendungan beserta waduknya; dan e. laporan kejadian khusus selama pengisian awal waduk.

6 PELAKSANAAN O&P BENDUNGAN

A6-3-No.005-111

PELAKSANAAN O & P BENDUNGAN

(Ps. 76,84-88,90-91,95-98)

Operasi & Pemeliharaan Bendungan beserta Waduknya terdiri atas:

a. Operasi dan Pemeliharaan bendungan;
b. Pemeliharaan Waduk; dan
c. Pemantauan Bendungan;

Operasi dan Pemeliharaan Bendungan, dimaksudkan untuk:

a. Mengoptimalkan pendayagunaan air dan daya air **(fungsi dan manfaat)**; dan
b. Menjaga keamanan bendungan **(keamanan).**

PERSIAPAN OPERASI PEMELIHARAAN (POP)

- POP ADALAH MASA TRANSISI DARI PEMBANGUNAN KE PENGELOLAAN
- DIPERLUKAN ORGANISASI POP YANG DITETAPKAN OLEH KEPALA BALAI DIDALAMNYA ADA UNSUR PEMBANGUN DAN ADA UNSUR PENGELOLA / UPB
- DALAM MASA TRANSISI INI DISERAHKAN DATA DAN TEKNOLOGI SERTA SARPRAS OP DARI UNIT PEMBANGUN KEPADA UNIT PENGELOLA

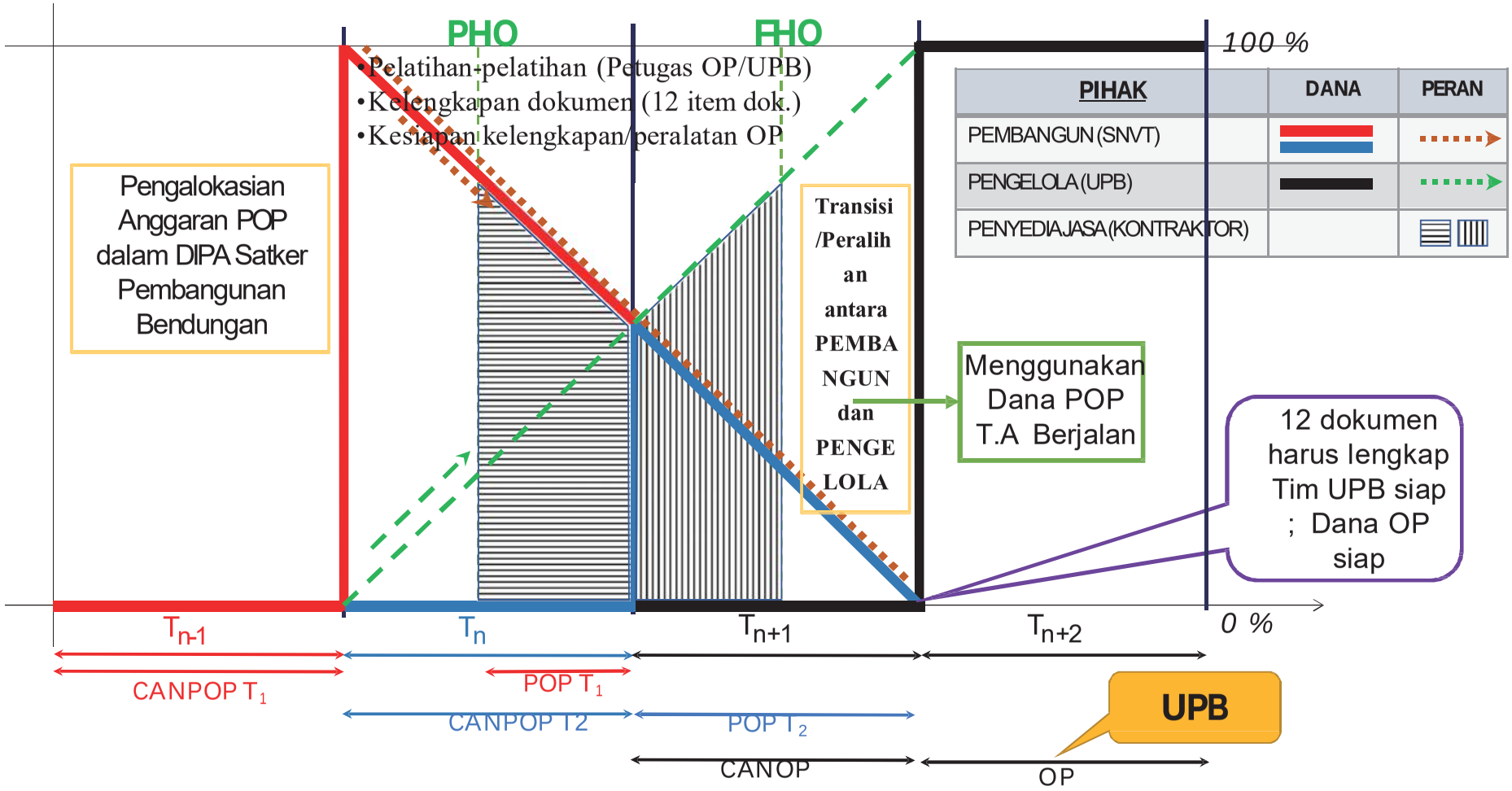
PERSIAPAN OPERASI PEMELIHARAAN (POP)

- ORGANISASI POP MEMBUAT PERENCANAAN POP (CANPOP) UNTUK MASA PALING LAMA 2 TAHUN ANGGARAN
- ANGGARAN DIPROGRAMKAN PADA UNIT PEMBANGUN UNTUK SETIAP TAHUN ANGGARAN
- MELAKSANAKAN POP TERINTEGRASI DENGAN KEGIATAN MASA PEMELIHARAAN KONSTRUKSI
- SELESAI MASA POP UNIT PENGELOLA SIAP UNTUK MENGELOLA

DOKUMEN YANG HARUS DISIAPKAN OLEH PEMBANGUN YANG HARUS DISERAHKAN KEPADA UPB PADA MASA POP

1. IZIN PENGGUNAAN SDA (Ps 10)
2. PERSETUJUAN PRINSIP PEMBANGUNAN BENDUNGAN (Ps 16) 5 TH, 1X
3. PERSETUJUAN DESAIN BENDUNGAN (Ps 24) **
4. DOKUMEN STUDI PENGADAAN TANAH DAN STUDI PEMUKIMAN KEMBALI (Ps 26)
5. IZIN PELAKSANAAN KONSTRUKSI BENDUNGAN (Ps 30) ** UNTUK 3 TH
6. RENCANA PENGELOLAAN BENDUNGAN YANG BERISIKAN
7. PEDOMAN OPERASI DAN PEMELIHARAAN BENDUNGAN BESERTA WADUKNYA (TERMASUK AKNOP) DILENGKAPI DENGAN
8. POLA OPERASI WADUK (5 TH) (Ps 45, 46, 47)
9. RENCANA TINDAK DARURAT/ RTD (Ps 53)
10. IZIN PENGISIAN AWAL WADUK (Ps 64) **
11. AS BUILT DRAWING
12. DOKUMEN LAPORAN AKHIR PELAKSANAAN KONSTRUKSI (PS 90) **
13. IZIN OPERASI (PS 92) **
14. PENETAPAN STATUS PENGGUNAAN (PSP) >>> **BMN / ASET**

SKEMA P.O.P BENDUNGAN



PERSIAPAN O&P

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL SUMBER DAYA AIR
P U S A T B E N D U N G A N
Jl. Pattimura No.20, Kebayoran Baru - Jakarta Selatan 12110, Telp/Fax. 27515389

Nomor : PR.05-01-Ag/295 Jakarta, 17 Juli 2018
Lampiran : 3 Lembar
Hal : Persiapan Operasi dan Pemeliharaan Bendungan

Kepada Yth.
Daftar terlampir
Di-
Tempat

Sehubungan dengan pelaksanaan pembanguanan 65 bendungan, terdapat beberapa bendungan yang telah selesai konstruksinya dari TA. 2015 hingga TA. 2018 (**Lampiran**). Untuk itu, dalam rangka persiapan pengelolaan bendungan agar dapat berfungsi dengan efektif dan efisien, maka bersama ini disampaikan hal-hal berikut:

1. Persiapan Operasi dan Pemeliharaan (POP) adalah masa transisi dari pembangunan ke pengelolaan bendungan yang seluruh kegiatannya masih merupakan kewajiban Pembangun Bendungan. Untuk melaksanakan POP, diperlukan organisasi pelaksana berupa berupa Tim POP yang ditetapkan oleh Kepala Balai dan didalamnya terdapat unsur dari pembangunan dan unsur pengelola.
2. Tugas Tim POP Bendungan adalah sebagai berikut:
   a. Memantau, memelihara mengoperasikan dan mengamankan bendungan yang telah selesai konstruksinya sejak dilakukan *Provisional Hand Over* (PHO) sampai dengan penyerahan Pengelolaan kepada Unit Pengelola Bendungan (UPB)
   b. Melaksanakan proses Sertifikasi Operasi dan Pemeliharaan (OP) sampai diterbitkan Ijin/Sertifikat OP.
   c. Mempersiapkan data, teknologi, sarana dan prasarana penunjang OP, serta dokumen yang akan diserahkan kepada UPB sesuai Permen PUPR No. 27 tahun 2015 berupa:
      1. Izin Penggunaan Sumber Daya Air (Ps. 10)
      2. Persetujuan Prinsip pembangunan Bendungan (Ps. 16)
      3. Persetujuan Desain Bendungan (Ps. 24)
      4. Dokumen Studi Pengadaaan Tanah dan Studi Permukiman kembali (Ps. 26)
      5. Izin Pelaksanaan Konstruksi Bendungan (Ps. 30)
      6. Rencana Pengelolaan Bendungan
      7. Pedoman Operasi dan Pemeliharaan Bendungan beserta Waduknya
      8. Pola Operasi Waduk (Ps 45, 46, 47)
      9. Rencana Tindak Darurat (RTD) (Ps. 53)
      10. Izin Pengisian Awal Waduk (Ps. 64)
      11. *As Built Drawing*
      12. Izin Operasi (Ps. 92)
      13. Penetapan Status Penggunaan (PSP)
   d. Membuat Perencanaan OP, rencana operasi tahunan waduk sampai dengan penyerahan pengelolaan kepada UPB, dan melakukan alih pengetahuan kepada UPB, dimana pelaksanaannya dapat terintegrasi dengan kegiatan masa pemeliharaan Konstruksi.
3. Untuk melaksanakan tugas Tim POP, maka dilaksanakan kegiatan-kegiatan yang penganggarannya diprogramkan pada SNVT Pembangunan Bendungan.
4. Pengelola bendungan dalam melaksanakan pengelolaan bendungan beserta waduknya dibantu oleh UPB, dimana setiap Balai sebagai Pengelola bendungan wajib membentuk UPB yang ditetapkan oleh Pemilik atau Pengelola Bendungan, sehingga dengan demikian setiap UPB siap untuk mengelola bendungan setelah masa Persiapan Operasi dan Pemeliharaan selesai.

Berkenaan dengan poin tersebut diatas, Kepala Balai agar dapat menginstruksikan jajarannya untuk mempersiapkan hal-hal yang diperlukan.
Demikian disampaikan, atas perhatian dan kerjasamanya diucapkan terima kasih

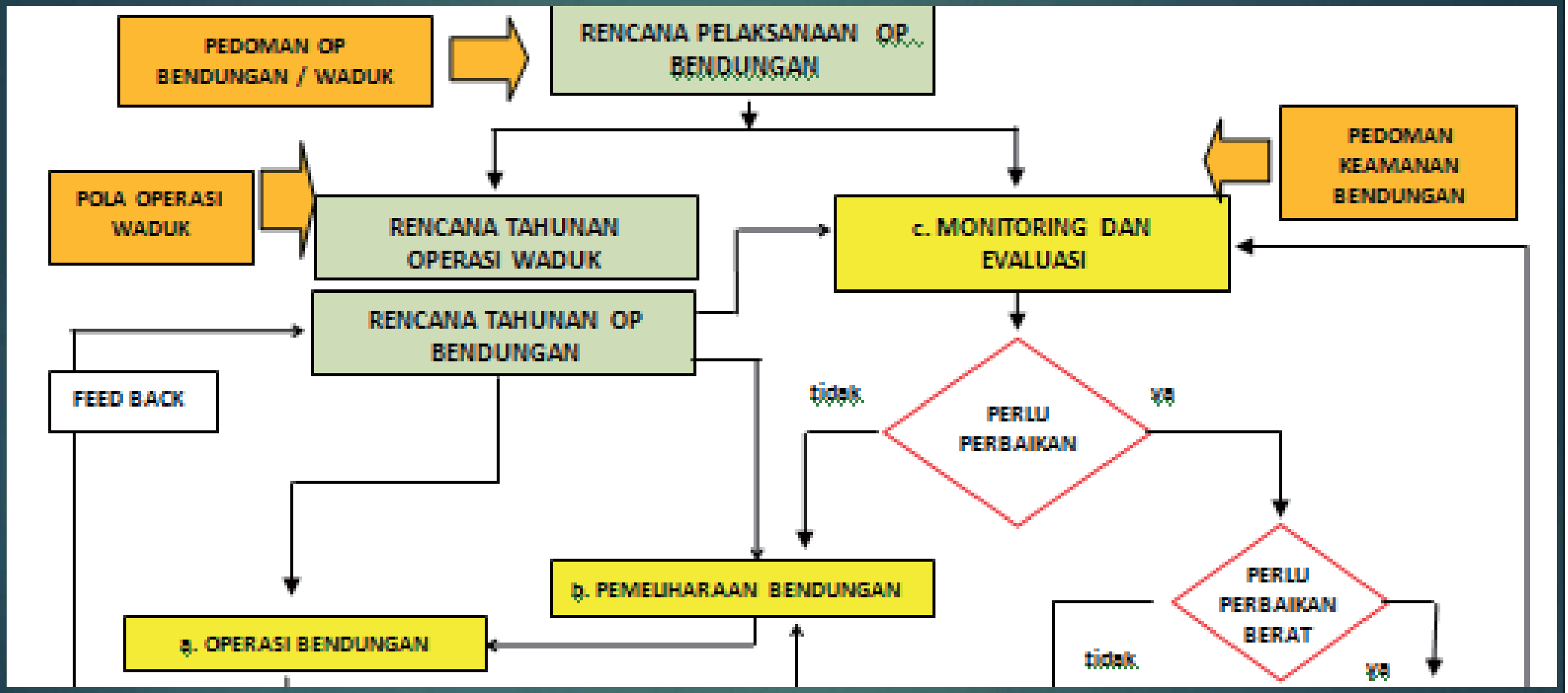
Kepala Pusat Bendungan

Dr. Ir. Ni Made Sumiarsih, M.Eng
NIP. 196002251986032005

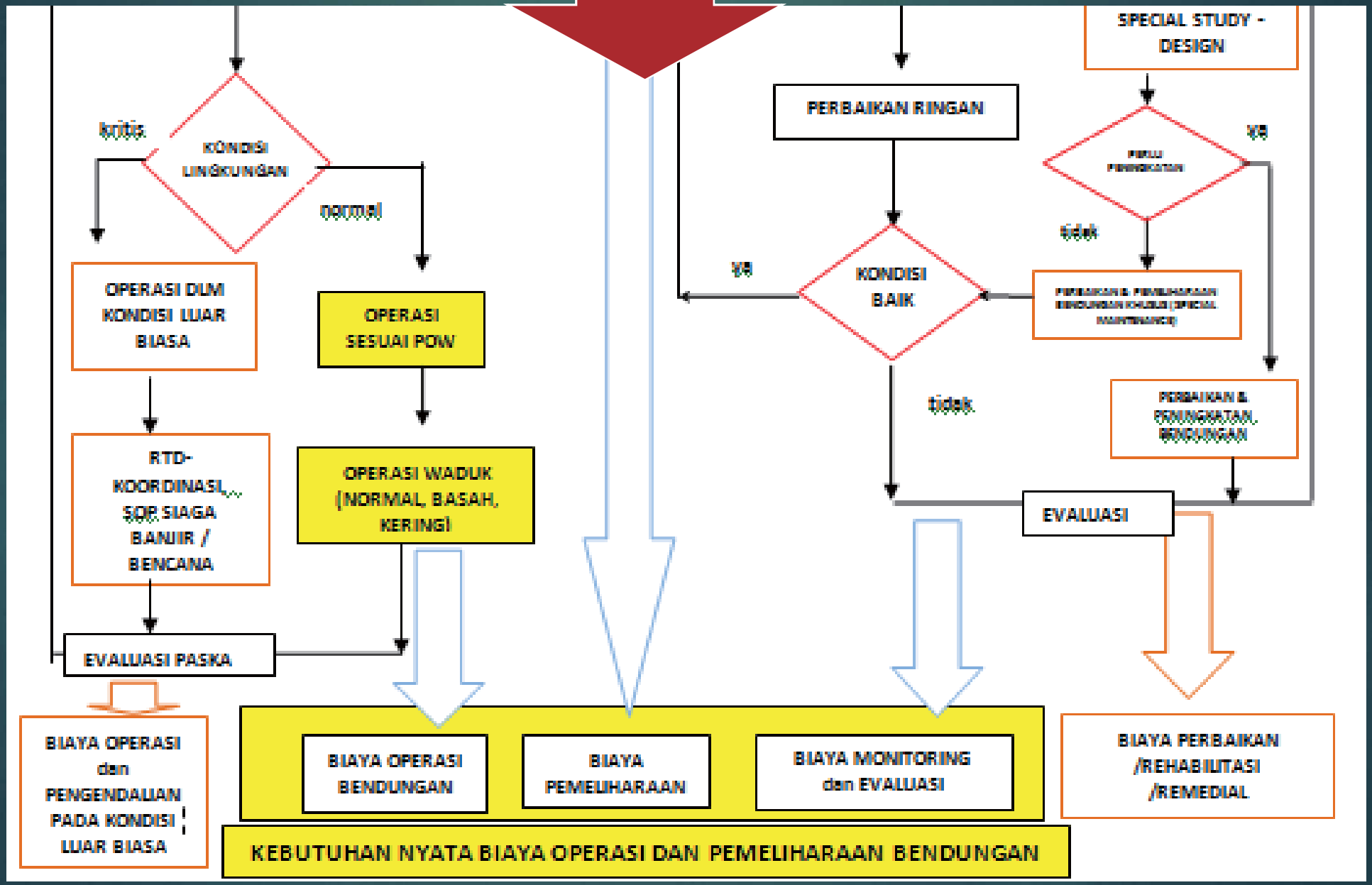
Tembusan Kepada Yth.
1. Direktur Jenderal Sumber Daya Air (sebagai laporan)
2. Direktur Pengembangan Jaringan Sumber Daya Air
3. Direktur Bina Operasi dan Pemeliharaan
4. Arsip.

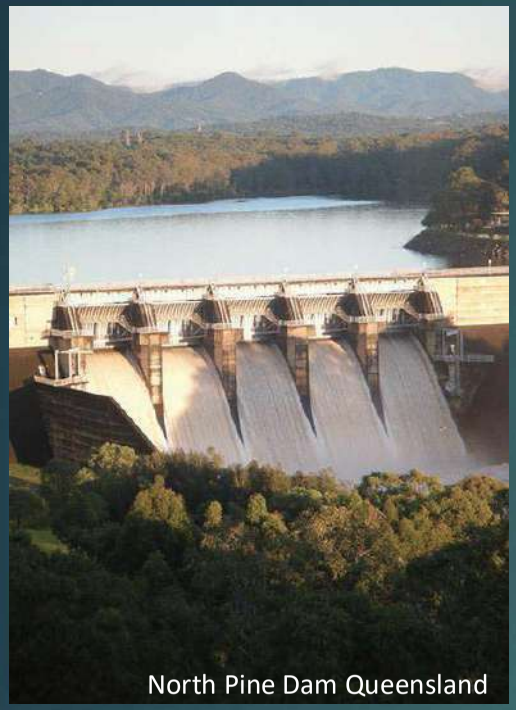
A6-3-No.005-117

FLOWCHART KEGIATAN O&P BENDUNGAN



FLOWCHART KEGIATAN O&P BENDUNGAN

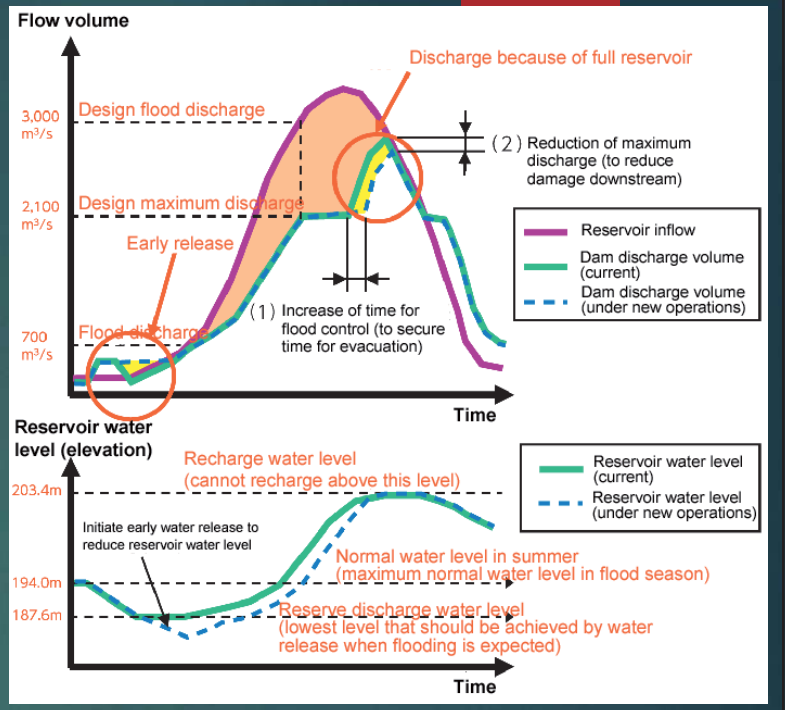



North Pine Dam Queensland

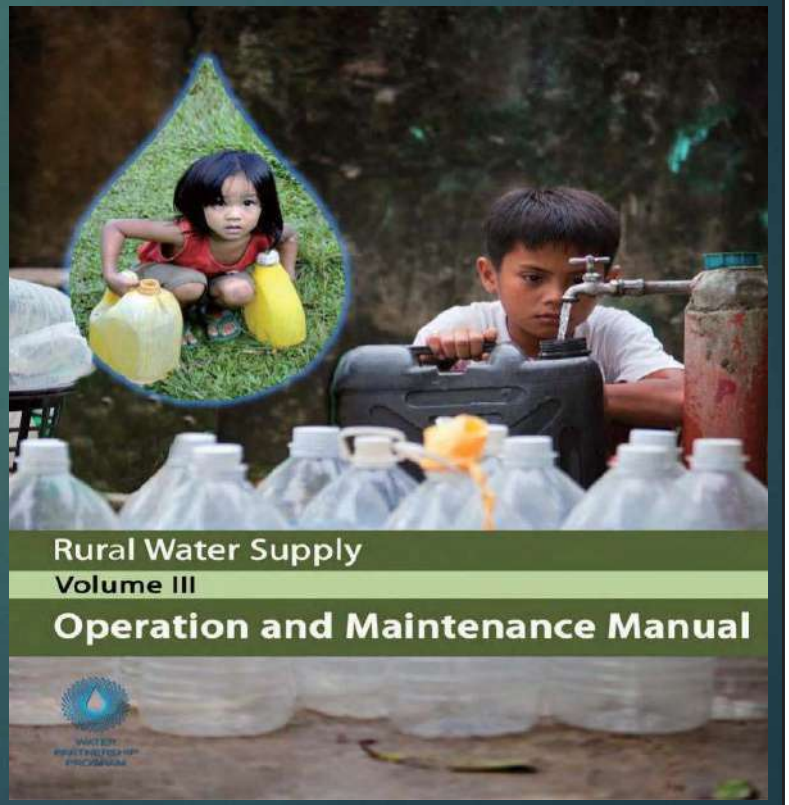
OPERASI BENDUNGAN

Operasi bendungan, dilakukan dengan mengatur keluaran air waduk guna pemenuhan kebutuhan air di hilir, pengendalian banjir, dan pengamanan bendungan pada keadaan darurat atau luar biasa.

Dalam hal terjadi keadaan darurat atau situasi luar biasa, operasi bendungan beserta waduknya diutamakan untuk tujuan keamanan bendungan dan keselamatan lingkungan hidup.



The Callide Dam, near Biloela in central Queensland, went into emergency release on the night the cyclone Marcia hit on February 20, 2015 flooded Jambin Town



OPERASI WADUK

(prosedur operasi yang mengatur volume pengeluaran/pengaliran/penggunaan

1. Kapasitas tampungan waduk
2. Banjir desain dan penelusuran banjir
3. **Prakiraan inflow**
4. **Jadwal pengisian dan prosedur pengeluaran air**
5. Petunjuk operasi
6. Operasi banjir
7. Keadaan darurat

North Pine Dam Queensland

The Collide Dam, near Biloela in central Queensland, went into emergency release on the night the cyclone Marcia hit on February 20, 2015 flooded Jambin Town

PEMELIHARAAN BENDUNGAN

Pemeliharaan bendungan/waduk dimaksudkan:

a. mempertahankan fungsi waduk sesuai dengan umur layan;

b. menjaga kuantitas dan kualitas air waduk; dan

c. menjaga keamanan bendungan.

Pemeliharaan meliputi:

1. *Pemeliharaan pencegahan, dilakukan*:

a. secara rutin (pemeliharaan rutin); dan

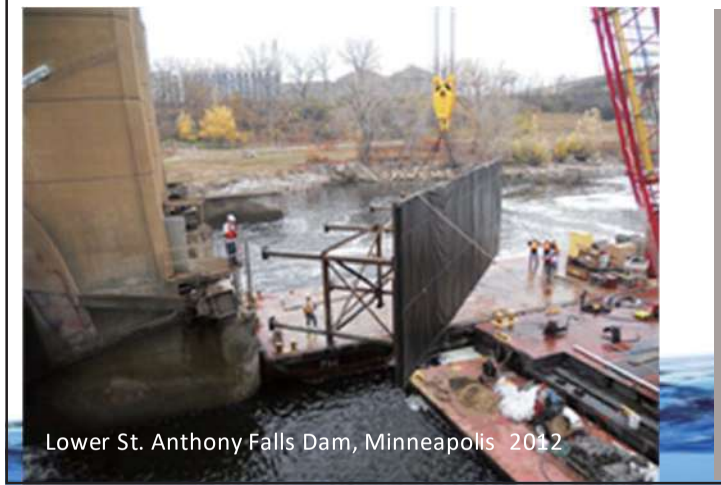
b. secara berkala atau terjadwal (pemeliharaan berkala).

2. *Pemeliharaan luar biasa meliputi:*

a. pekerjaan perbaikan (*repair, remedial work*);

b. pekerjaan perkuatan; dan

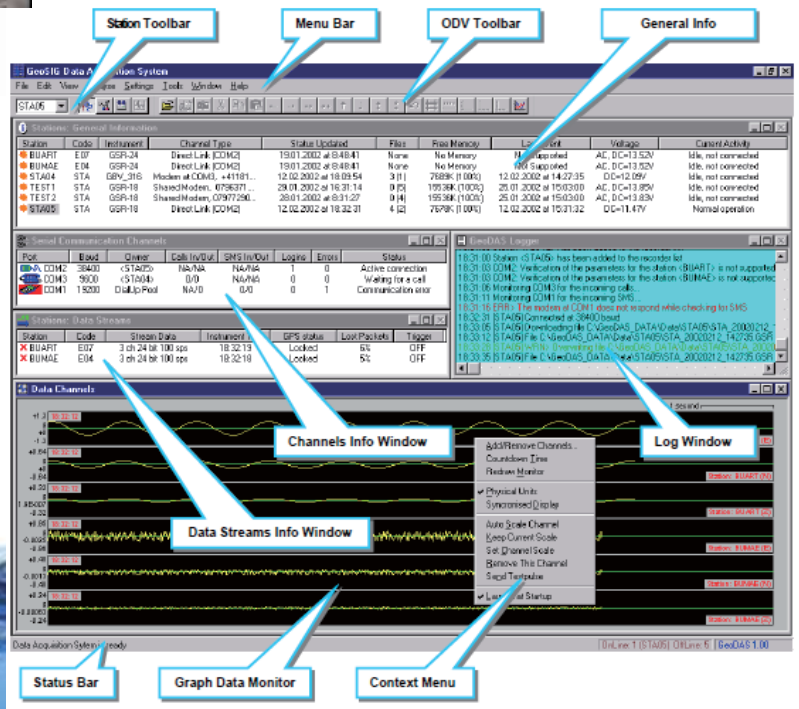
c. rehabilitasi.



PENGAMATAN BENDUNGAN

Pemantauan bendungan dilakukan dengan tujuan untuk mengetahui gejala permasalahan pada bendungan secara dini guna pengambilan tindakan oleh pengelola bendungan secara cepat dan tepat.

CONTOH PEMBACAAN ACCELEROGRAPH



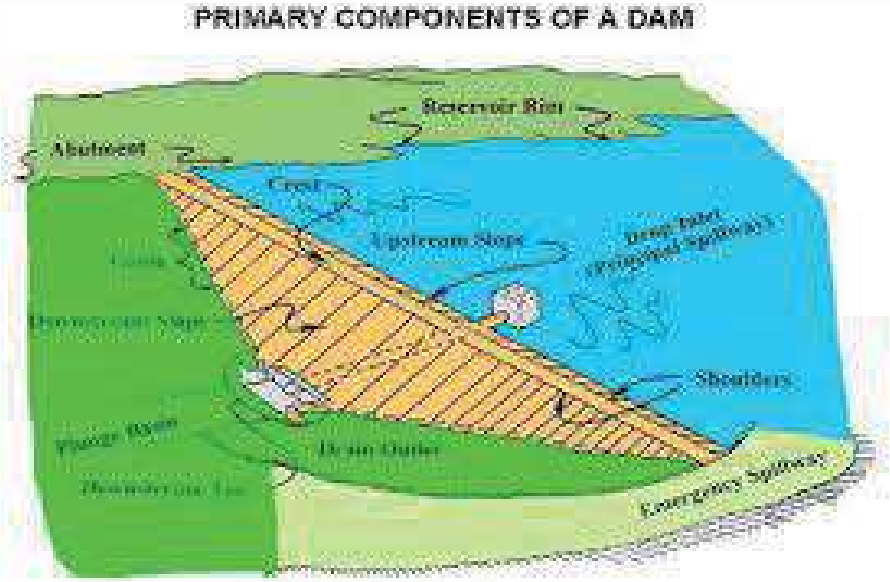
PENGAMATAN (Surveillance)

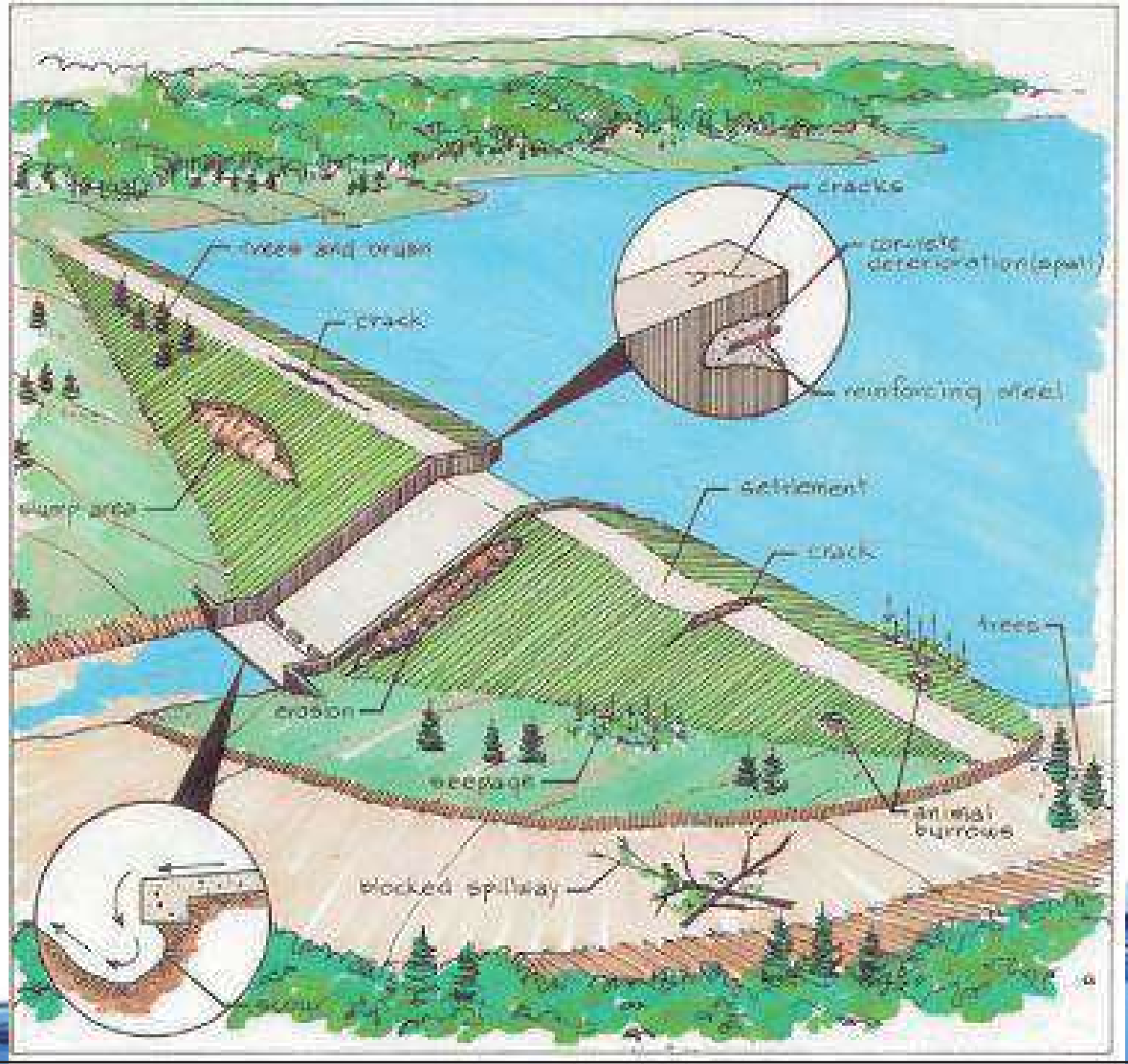
1. Monitoring/pemantauan (desain/gambar, frekuensi & peningkatannya, pengukuran, pemeliharaan system pemantauan, personil, catatan & laporan)

2. Pemeriksaan visual (pemeriksaan yang teratur, objek pemeriksaan mekanikal & elektrikal, kemungkinan terjadi kerusakan & objek yang diperiksa)

3. Evaluasi (awal) & pelaporan berdasarkan data monitoring, inspeksi lap rutin & khusus (frekuensi pemeriksaan, pelaporan pemeriksaan, pengamatan)

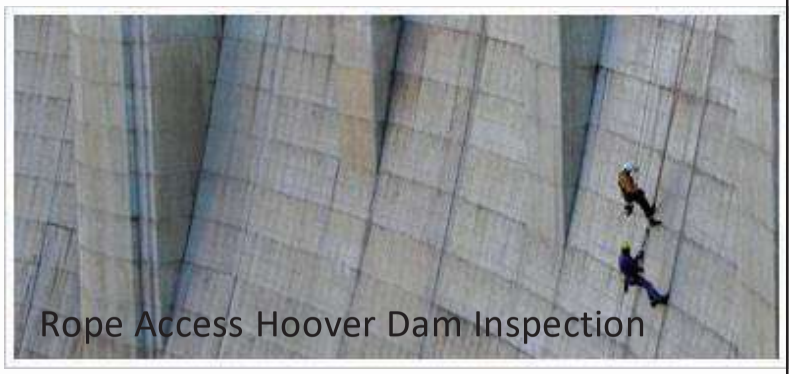
PEMERIKSAAN BENDUNGAN





IINSPEKSI (tahunan, besar, khusus)

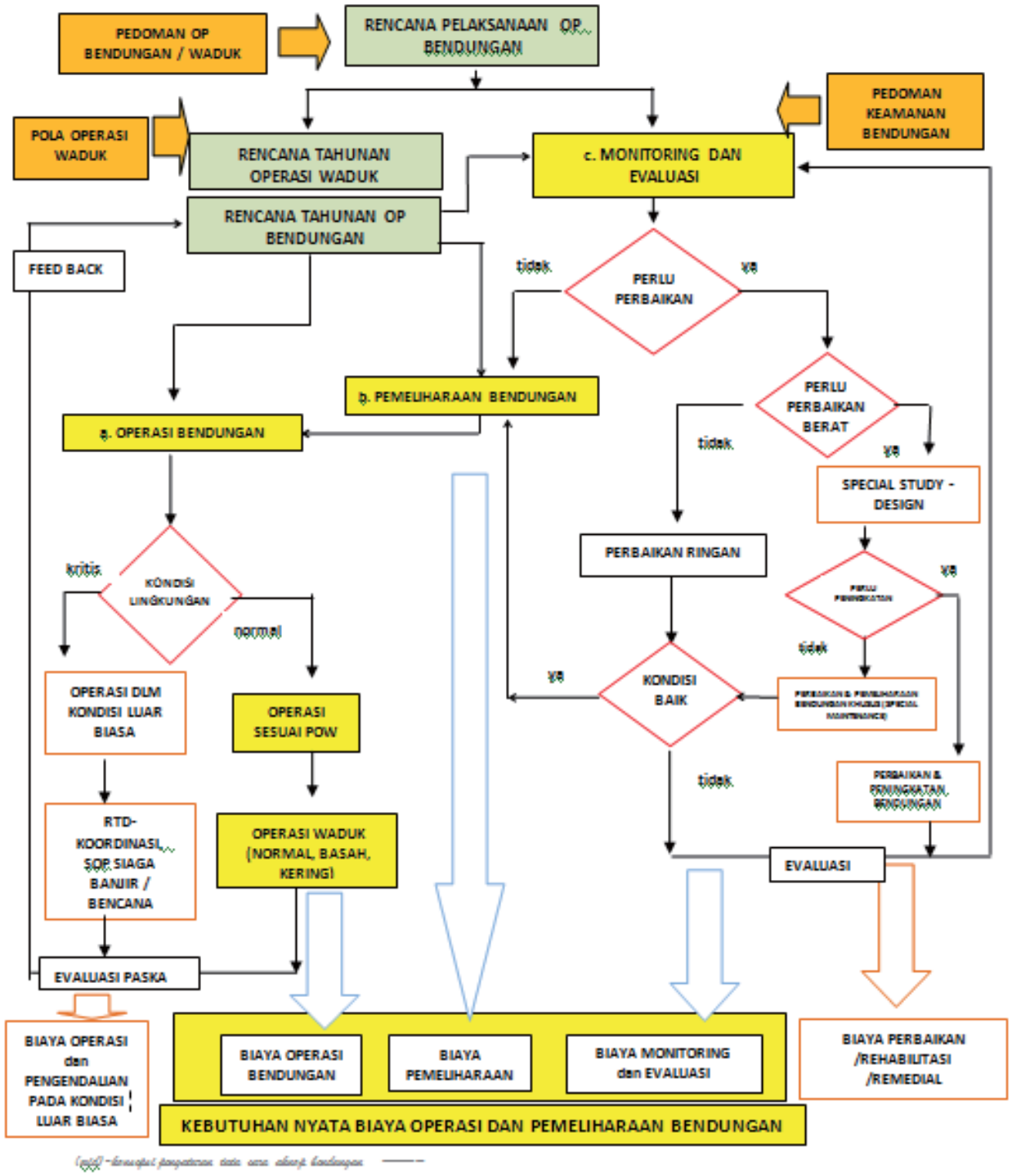
(Ps. 147-149)


Rope Access Hoover Dam Inspection

Grafton dam gets underwater inspection

Corps' engineers climb, inspect New Hogan Dam

FLOW CHART BIAYA O&P BENDUNGAN



Kondisi jembatan rumah penduduk yang menempel pada tubuh waduk Saradan

BENDUNGAN GINTUNG (Situ Gintung)

Badan tanggul disebelah kiri bangunan pelimpah, nampak bagian puncak tanggul yang mengalami penurunan dan lapisan perkerasan permukaan yang pecah-pecah
(Foto Tommy sekitar tahun 2005).

A6-3-No.005-129

Bagian badan tanggul yang runtuh, nampak dibagian tengah singkapan batuan dasar tanggul dan pelimpah

A6-3-No.005-130

Eceng Gondok di Waduk Pengga

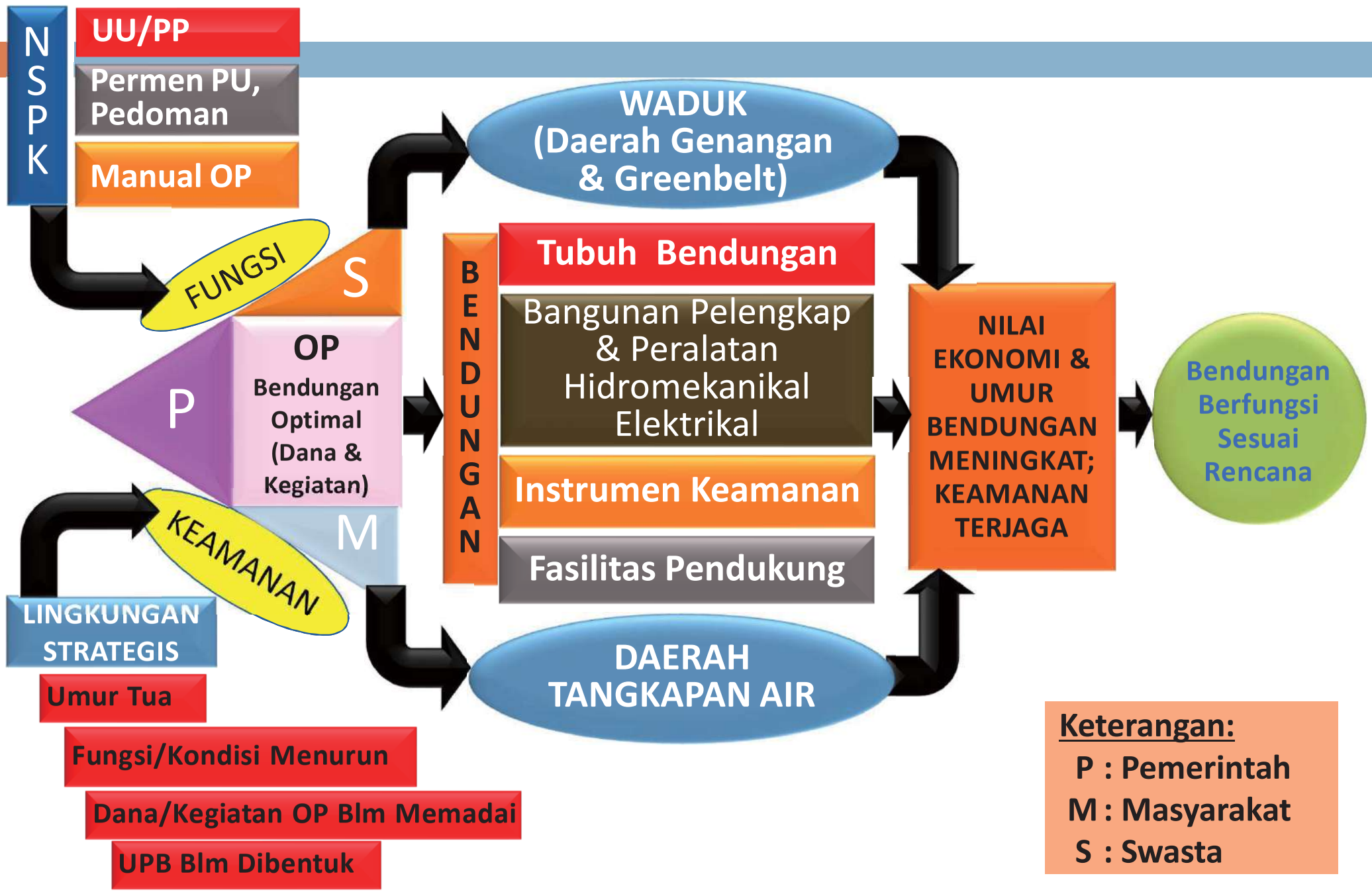
A6-3-No.005-131

AKIBAT OPP BENDUNGAN DIABAIKAN

- Kondisi bangunan cepat rusak sebelum umur rencana;
- Bahaya bencana yang ditimbulkan;
- Fungsi pelayanan masyarakat akan prasarana tidak sesuai rencana;
- Kegagalan tujuan pembangunan, dalam hal ini memperburuk kredibilitas/citra pemerintah.

7 O&P BENDUNGAN TERPADU

O&P BENDUNGAN TERPADU



PENYELENGGARAAN O&P TERPADU

- Partisipasi Masyarakat;
- Operasi dan Pemeliharaan dengan prioritas fokus pada daerah yang berpotensi penyebab keruntuhan bendungan;
- Harmoni antara keamanan dan fungsi bendungan;
- Pemenuhan persyaratan pengelolaan bendungan, pengadaan personil, pembiayaan, dan peralatan (software & hardware);
- Alokasi biaya sesuai dengan kebutuhan dan prioritas penanganan dan pelaksanaan OP sesuai dengan pedoman dan kondisi bendungan.

Thank You
Drone Aerial Photo Technology
Safety Flying