MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

**VIETNAM DISASTER MANAGEMENT AUTHORITY**

# Flash Flood and Landslide in Vietnam

Present: Science, Technology and International Department

*Hanoi, 10/2019*

# Outline

1. Overview of Flash Flood and Landslide in Vietnam

2. Legal Document on Management of Flash Flood and Landslide in Vietnam

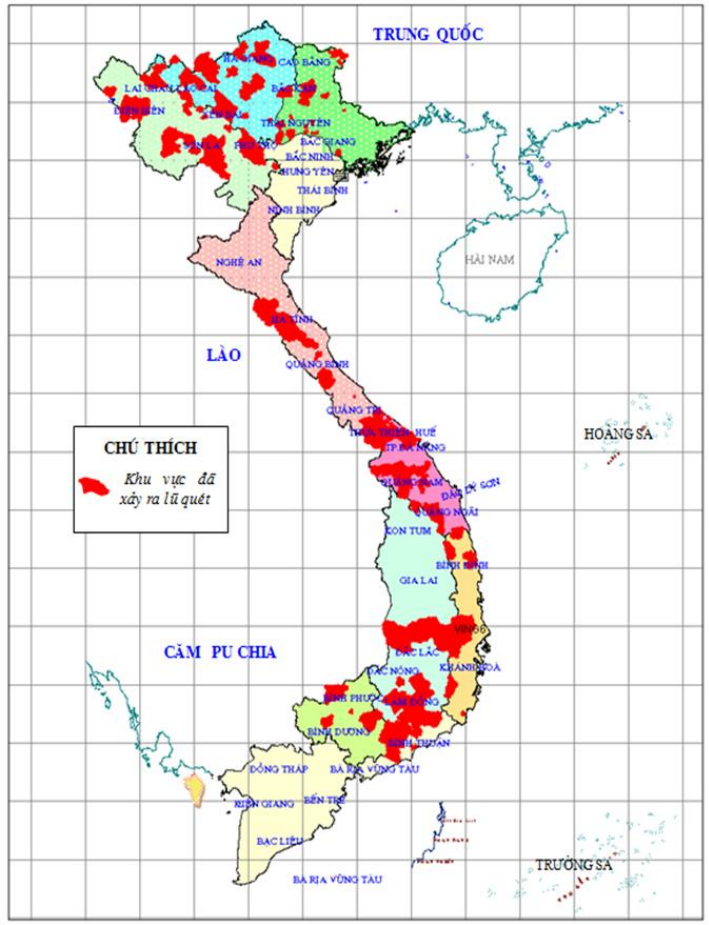
3. Solutions of Flash Flood and  Landslide Management in Vietnam

4. Conclusion and Recommendation

# 1. Overview of Flash Flood and Landslide in Vietnam

## Damage caused by flash flood and landslide

- Occur in most of the provinces in the North and Middle of Vietnam
- **1953 - 2016**: 448 times
  (Ave.: 7 times /year)
- **2000 – 2015**:
  - 779 ppl.
  - 426 ppl.
  - 9.700 houses
  - 100.000 houses
  - 75.000 ha
  - 250 times
  (Ave.: 15-16 times/year)



# 1. Overview of Flash Flood and Landslide in Vietnam

**Damage caused by flash flood and landslide**

**In 2018**, in the north mountainous area:

14 times

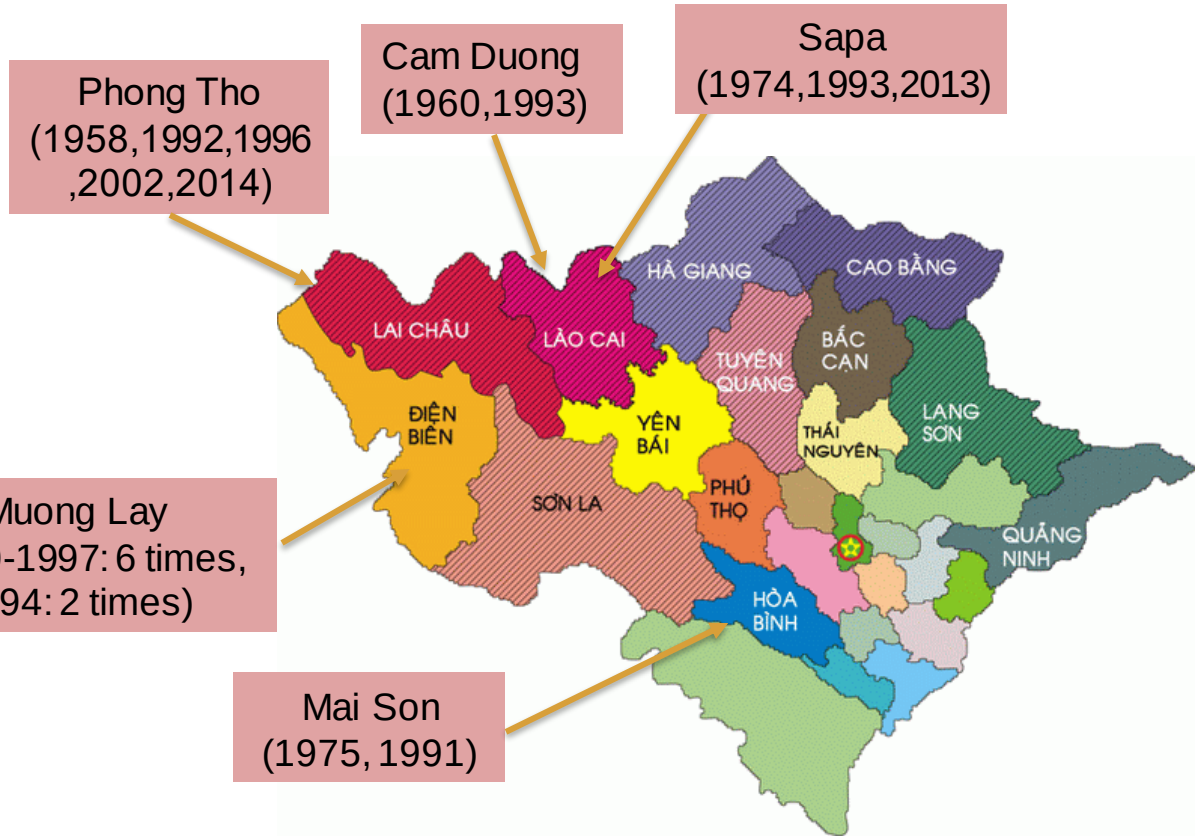
82 ppl. (70%)

10.300 billion VND (52%)

# 1. Overview of Flash Flood and Landslide in Vietnam

## Characteristics of Flash flood and Landslide in Vietnam

- Most of flash flood and landslide occurred in remote locations
- Those disasters happen every year in Vietnam, and its frequency tends to increase



# 1. Overview of Flash Flood and Landslide in Vietnam

**Bat Xat, Lao Cai** 05/8/2016

11

143

**Nam Pam, Son La** 02-03/8/2017

15

15

279

# 1. Overview of Flash Flood and Landslide in Vietnam

**Mu Cang Chai, Yen Bai** 03/8/2017

14

156

**Sa Na, Thanh Hoa** 03/8/2019

10

22

## 2. Legal Documents on Management of Flash Flood and Landslide in Vietnam

The Vietnam Parliament and Government have provided laws and strategies related to disaster risk management which include flash flood and landslide:

- ✓ Law on Natural Disaster Prevention and Control (2013)
- ✓ Law on Dyke Management
- ✓ Law on Forestry and Forest Development Strategy
- ✓ Law on Environment Protection Strategy
- ✓ Law on Water Resources
- ✓ Land Law
- ✓ Law on Mineral Resources

## 2. Legal Documents on Management of Flash Flood and Landslide in Vietnam

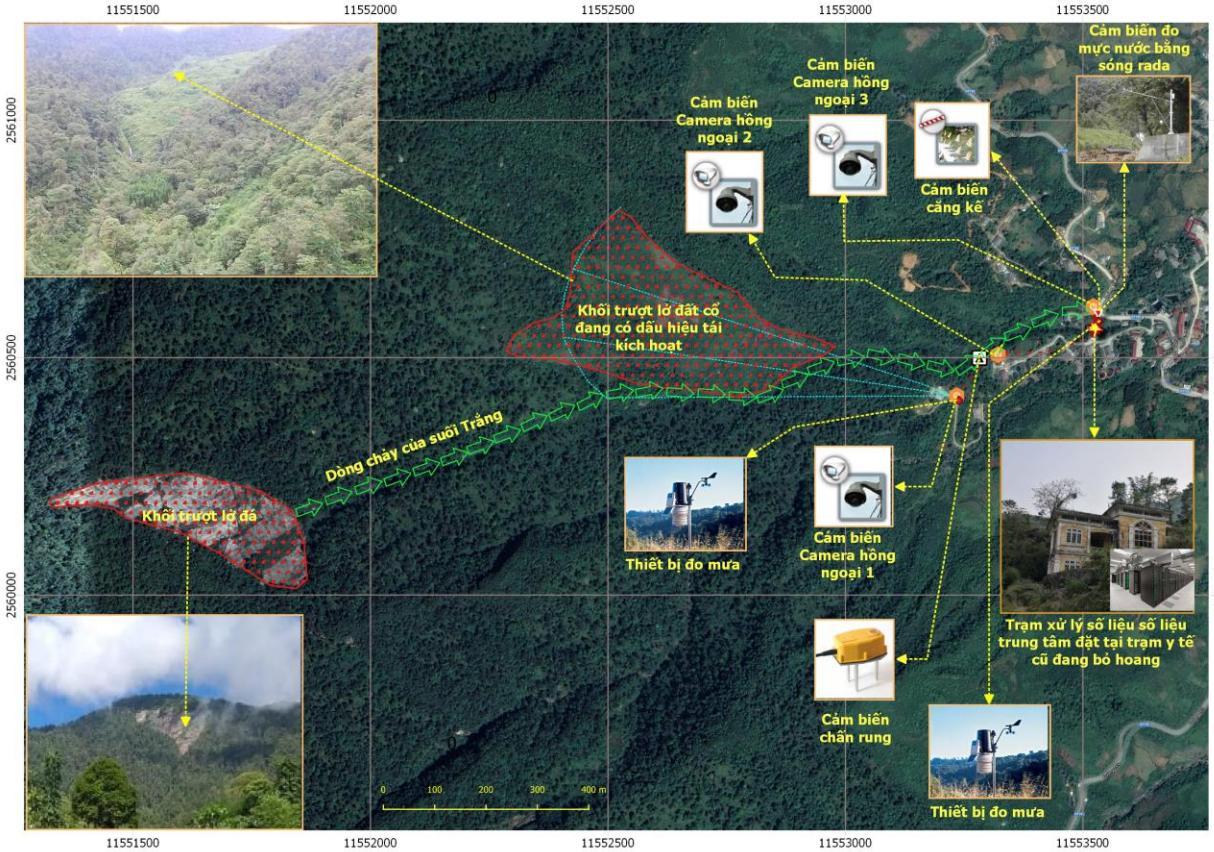
- June 18, 2018, the Government promulgated Resolution No. 76/NQ-CP on natural disaster risk management, in which it emphasizes " identifying the location where flash flood and landslide have high chance to occur in order to implement structural and non-structural solutions".
- July 13, 2018, Prime Minister promulgated Directive No. 19/CT-TTg on flash flood and landslide prevention.
- November 29, 2018, the Government promulgated Decree No. 160/2018/NĐ-CP on guideline of implementing the law on natural disaster prevention.

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.1. Enhance the early warning system

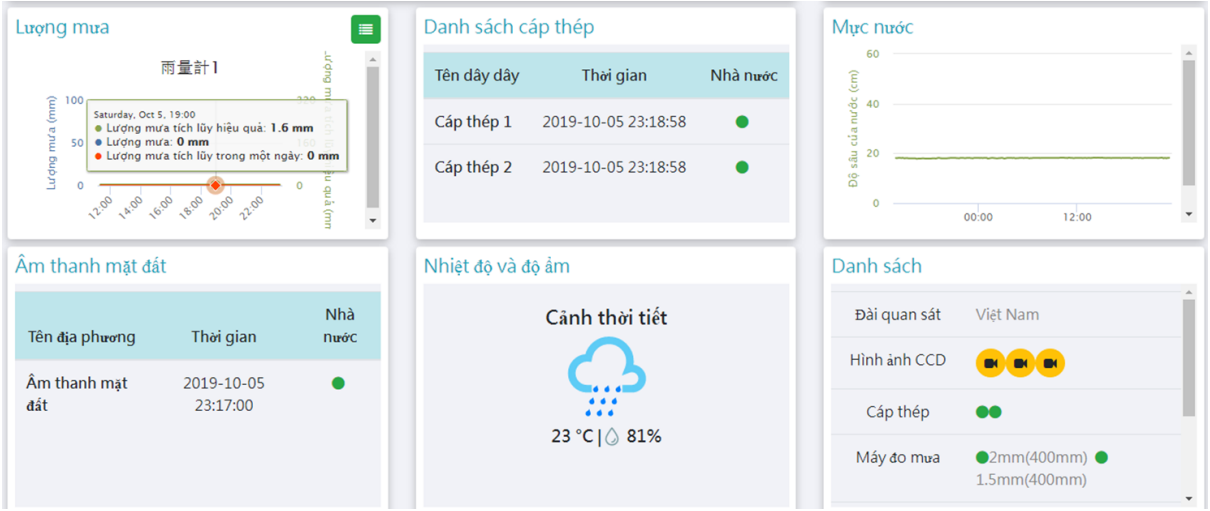
Debris flow early warning design in Ban Khoang, Sapa Distr., Lao Cai Province

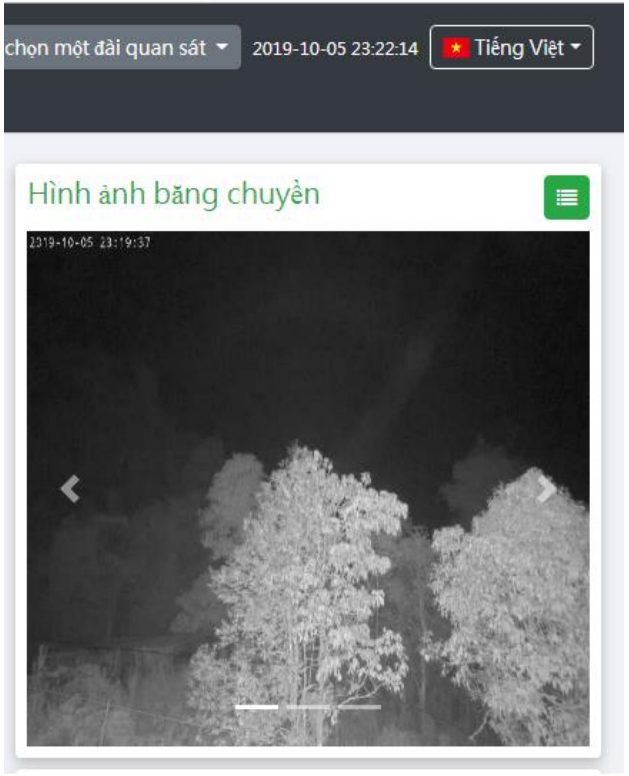
(*Cooperation of VIGMR and SWCB, Agrimedia*)



# 03. Solutions on Flash Flood and Landslide Prevention

## 3.1. Enhance the early warning system



# 03. Solutions on Flash Flood and Landslide Prevention

## 3.2. Raise community awareness of flash flood and landslide

VNDMA applies technology and science in communication and raising public awareness of natural disaster in general and flash flood and landslide in particular

Social Network

E-learning

Workshop

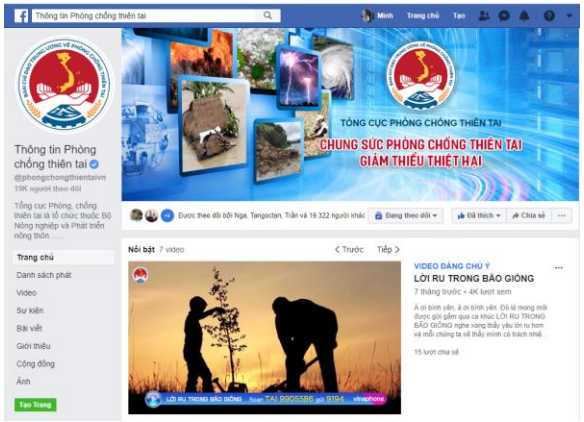

Message


Smartphone App

Visualization

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.2. Raise community awareness of flash flood and landslide






TIN THIÊN TAI NGÀY 30/4
1. TÌNH HÌNH MƯA
- Ngày 29/4: B.Bộ và T.Nguyên mưa vừa, có nơi mưa to, ph.biến từ 10-30 mm, một số trạm lớn: Vĩnh Yên (L.Cai) 40mm, Bắc Quang (H.Giang) 83mm, Vĩnh Tuy (H.Giang) 63mm, Kon Tum (K.Tum) 47mm.

- Mưa đêm (từ 19h/29/4 đến 07h/30/4): Bắc Bộ có mưa vừa, có nơi mưa to, phổ biến từ 20-50mm, một số trạm mưa lớn như: Tam Đảo (V.Phúc) 91mm, Bắc Giang (B.Giang) 62mm, Hà Đông (H.Nội) 64mm, Láng (H.Nội) 70mm.

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.3. Provide warning equipment for communities where flash flood and landslide can occur

Hand over the early warning equipment to local authorities; training community based disaster risk reduction

- Green Annamites project (USAID) (7/2019)
- Thanh Phat Co. Ltd. handed over 500 sets of portable speaker to village chiefs in 09 provinces in the North mountainous region (5/2018)

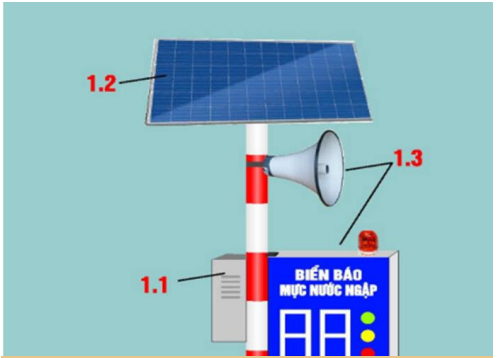

*Instruction of portable speaker in Phong Binh commune(Thua Thien Hue Province)*

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.3. Provide warning equipment for communities where flash flood and landslide can occur

July 2018, VNDMA and Agrimedia provided:

- 500 automatic early warning devices for rainfall in 09 provinces in the North region;
- 10 automatic early warning devices for flood water level, traffic lights and 02 iMetos (intelligent automatic meteorology station, EU standard) in Lao Cai and Yen Bai Province.




**Flood early warning system**


**Rain gauge and threshold measurement**

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.3. Provide warning equipment for communities where flash flood and landslide can occur

**Advantage**: Have effect immediately, help people in the disaster zone to respond promptly

**Disadvantage:** Depend on the user's responsibility



Mr. Ca Van Bien – Village chief, Nam Pam Com., Muong La Distr., Son La Province

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.4 Strengthening activities of private sector

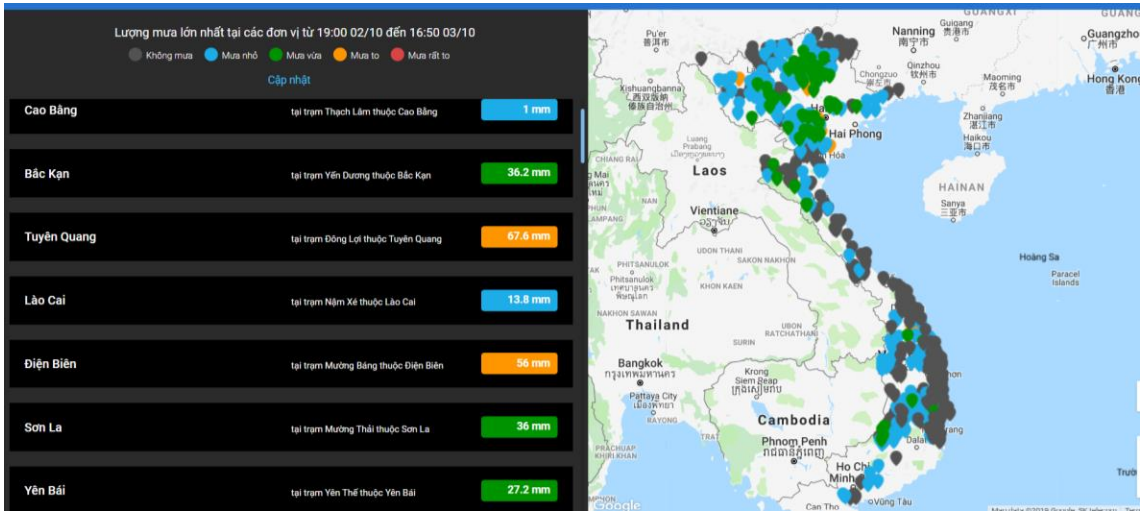
**WATEC** developed the automatic rain gauge system **VRAIN**
August 2018: **300** stations

**Agrimedia** provides solutions for weather and agriculture

| | |
|---|---|
| **Number of station (6/2019)** | **167** |
| **Water level station** | **34** |
| **Rain gauge station** | **85** |
| **Multi-purpose station** | **48** |

- Complete equipment, service packages from installation to operation and maintenance
- Easy access via internet (browse, smart phone application)

# 03. Solutions on Flash Flood and Landslide Prevention

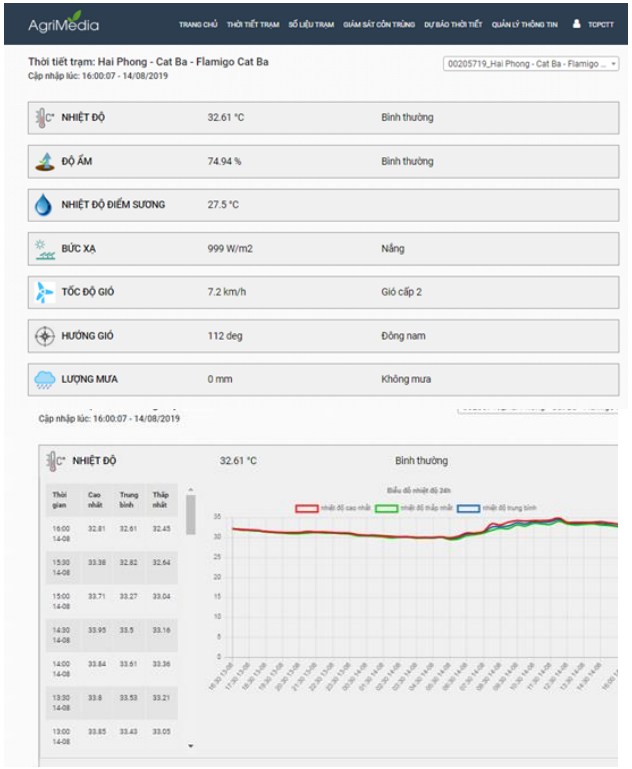


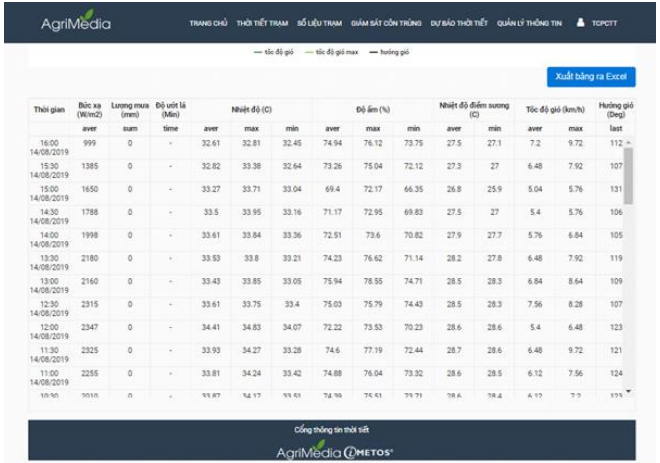

*Data output by Vrain (web browse)*

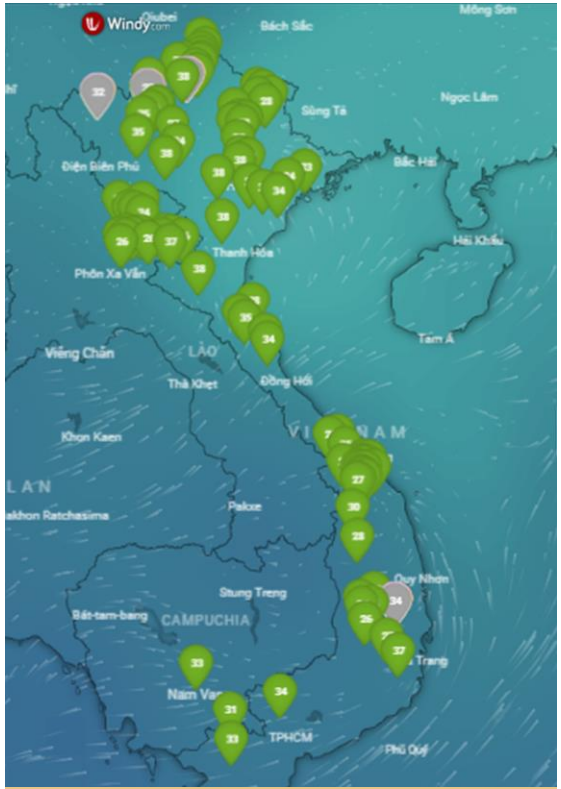
*Automatic Rain Gauge station in Hoa Binh (09/2019)*

# 03. Solutions on Flash Flood and Landslide Prevention

*Data Output and station system of Agrimedia*




**Agrimedia stations**

# 03. Solutions on Flash Flood and Landslide Prevention

## 3.4. Strengthening activities of private sector

**Advantage:**

- Utilize the resources from private sector
- These companies (Watec, Agrimedia…) are capable to research and apply up-to-date technology that is suitable for Vietnam
- Provide many services

**Disadvantage:**

Lack of National standard for imported equipments

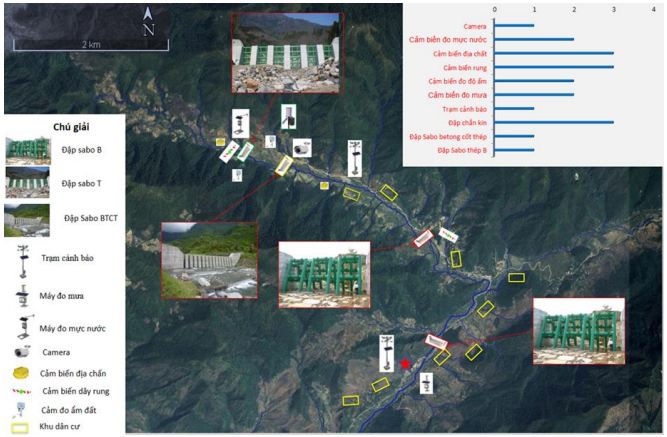
# 03. Solutions on Flash Flood and Landslide Prevention

## 3.5. VNDMA is proposing programs and projects to prevent flash flood and landslide

- Project "Installing and testing the early observation and warning system in order to reduce risk of flash flood and landslide at high-risk locations" (2020 -2025)
- Program "Building observation, warning systems and construction to prevent and respond debris flow at high-risk locations in the north mountainous area" (2021-2025)
- In cooperation with JICA: Strengthening the capacity to cope with and minimize damages caused by flash floods and landslides for the north mountainous area (2019-2022)

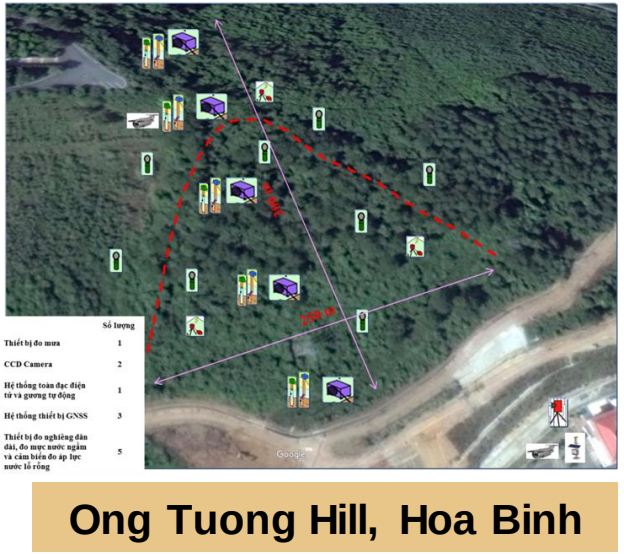
# 03. Solutions on Flash Flood and Landslide Prevention

**Project:** Installing and testing the early observation and warning system in order to reduce risk of flash flood and landslide at high-risk locations




**Nam Pam, Muong La, Son La**

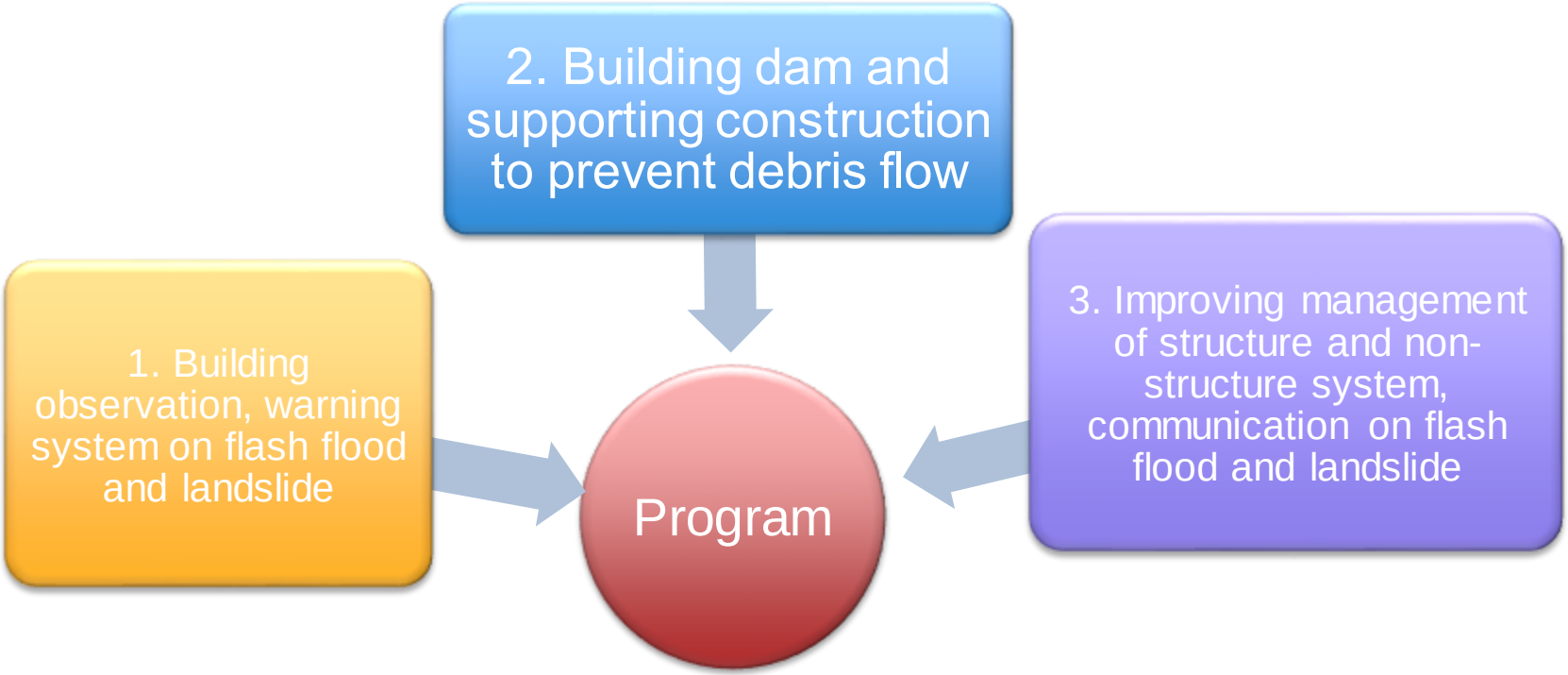

**Mu Cang Chai, Yen Bai**




**Ong Tuong Hill, Hoa Binh**

# 03. Solutions on Flash Flood and Landslide Prevention

**Program:** Building observation, warning systems and construction to prevent and respond debris flow at high-risk locations in the north mountainous area



# 4. Conclusions and Recommendations

## 4.1 Conclusions

- Flash flood and landslide occur more often and cause huge loss, especially in mountain area
- Socialize in field of disaster prevention has utilized resources from private sector and proved its potential
- The early warning system that was invested by foreign organizations has only created an approach to new technology and it requires more time to evaluate.

## 4.2 Recommendations

- Mandate immediately the Resolution No. 76/NQ-CP on natural disaster risk management
- Focus more on flash flood and landslide research
- Taking more actions on education; rise community awareness; complete guideline for flash flood and landslide
- It need to implement soon the pilot project of early observation and warning system for debris flow in the north mountainous area
- Develop planning on flash flood and landslide prevention, especially at the high-risk locations
- Provide policies to support private sector for disaster management in general and flash flood and landslide in particular

# Trân trọng cảm ơn!

The Central Steering Committee for Natural Disaster Prevention and Control

**STANDING OFFICE**

# REPORT

## FLASHFLOOD AND LANDSLIDE IN QUAN SƠN DISTRICT, THANH HÓA PROVINCE

## AND EXPERIENCE LESSONS

*Ha Noi, October 2019*

# CONTENTS


1 FLASHFLOOD AND LANDSLIDE IN SA NÁ AND IN SOME OTHER LOCATIONS

2 CAUSES AND LESSONS LEANRT

3 CHALLENGES AND SOLUTIONS

4 THINGS TO BE DONE

# I. FLASHFLOOD AND LANDSLIDE IN SA NÁ VILLAGE AND IN SOME OTHER LOCATIONS

## I.1 MAINTENANCE AREAS: NORTH AND NORTH CENTRAL REGIONS

2018: **14 floods; deaths and missing: 82 people** (70% nationwide), damages: VND 10,300 billion (52% nationwide)

Early 2019 so far: **6 floods; 27 deaths and missing and damages estimated at VND 1,000 billion .**

**Mường Lát- Thanh Hóa (2018)**
06 deaths; damages: VND 732 billion

**Mường La -Sơn La (2017)**
15 deaths; damages: VND 705 billion

**Sìn Hồ - Lai Châu (2018)**
23 deaths; damages: VND 270 billion

***Thanh Hóa (aftermath of typhoon No. 3 ):***

- **16 deaths and missing (Quan Sơn 13, Mường Lát 3)**
- **Estimated damages: VND 914 billion**

# I. FLASHFLOOD AND LANDSLIDE IN SA NÁ AND IN SOME OTHER LOCATIONS

## I.2 SA NÁ VILLAGE, NA MÈO COMMUNE, QUAN SƠN DISTRICT

- **10 deaths and missing** (06 people are buried in soil and rocks, not yet rescue)
- **35** houses completely collapsed; 02 schools and 01 cultural house are drifted away.
- 156.3 ha of rice and upland crops are swept away
- **Damages: VND 120 billion**


# II. CAUSES AND LESSONS LEARNT

## II.1 TOPOGRAPHICAL CHARACTERISTICS, ECONOMIC PEOPLE

- Sa Na village is located along Son stream which originates in Laos. The elevation of the catchment area (the highest point of the basin) is 1,722m; (in Sa Na, it is at el. 1,600m). About 2.4km away from Sa Na village, the Son stream is narrowed (57m in difference between the widest and narrowest sections).
- 74 households are allocated along the stream which is 6-7m higher than stream bed;
- Transport condition: there is a unique path along the Son stream to the Sa Na Village.
- The combined community cultural house and shelter is located 10m higher than the stream bed;
- In the flood season, the Sa Na village is often flooded;


**Where the** Son stream is narrowed (57m in difference between the widest and narrowest sections).

***Causes***

- The catchment area is large and steep which relates to quick concentration of flood water and flashflood is inevitable.
- The Son stream bed becomes narrow and widen to create bottlenecks as a precondition of a natural dam to raise water level.

***Lessons learnt:***

- It is risky for residents living near the stream banks
- The shrunken parts of streams can result in swollen sections and cause flashflood.

# II. CAUSES AND LESSONS LEARNT

## II.2 Flood forecast and warning:

- **FORECAST**

Day 2 August *(National Centre for Hydro-Meteorological Forecasting (NCHMF) in Thanh Hoa Province*: Heavy rain with a total rainfall of 200-400mm *(the specific rainfall in Quan Son district cannot be forecasted).*

- **REALITY**

Heavy rain during 3 a.m. -7 a.m. o 03 August in Na Meo district; the rainfall is over 200mm and increases by 70.3mm / h (at 7a.m. on 3 August).

***Causes:***

It is impossible to forecast rainfall in a short period of time, especially high intensity rainfall.

It is impossible to forecast rainfall from the upstream part in other territories

***Lessons learnt:***

*Install immediately rain gauging stations and disaster warning devices in areas prone to flash floods and landslides.*

# II. CAUSES AND LESSONS LEARNT

## II.3 DISASTER RESPONSE STEERING ACTIVITIES

-All people in the village were timely informed so they carried following activities very quickly:

-- At 7h40 a.m. (3 August) during the first flood: all local people have been evacuated to the community cultural houses, and they returned to their home after that.

-- 8 a.m. (3 August), the second flood has swept away 22 houses; 11 houses and cultural houses collapsed and 02 schools collapsed

***Causes:***

The flood was too big and happened unexpectedly

The obstructed section on Son stream where the stream becomes narrow burst and caused flash floods;

***Lesson learnt:***

There should be response plans for heavy rain and floods

Obstructed flow should be cleared.

Evacuation areas must be minimally equipped and ensure safety of people

# III. MỘT SỐ TỒN TẠI VÀ GIẢI PHÁP KHẮC PHỤC

## III.1 CÔNG TÁC PHÒNG NGỪA

| CHALLENGES | SOLUTIONS |
|---|---|
| ➢ *Most of local authorities have not inspected residential areas to ensure that they will be safe enough before flashfloods and landslides;*<br>➢ *Flashflood and landslide preparedness and response plans are not specific and practical and are not synchronously implemented at grassroots level.*<br>➢ *4-on-the-spot: limited supplies and equipment (life jackets, minimum equipment needed for rescue are not available).* | ➢ *Proactively check safe shelters for the possible evacuation of affected people; Check, detect and clear flows at blocked points.*<br>➢ *Prepare evacuation plans for people living in areas of high flashflood risks; prepare plans to approach the isolated areas.*<br>➢ *Prepare food, daily necessities, medicines, natural disaster prevention and control facilities (flashlights, life jackets ...). Equip traditional devices (portable speakers, gongs...)* |

# III. SOME CHALLENGES AND SOLUTIONS

## III.2 DISASTER RESPONSE ACTIVITIES

| CHALLENGES | SOLUTIONS |
|---|---|
| • *The area was reached only 2 days after the disaster*<br>• *The area is isolated area for a long time*<br>- *Communication system is interrupted and no information of the affected area is available and*<br><br>*AND as the result, search and rescue and response measures cannot be worked out and launched to timely save affected people*<br><br>  <br>*It takes 4 – 5 hours before the search and rescue team arrived the site* | ❑ There must be a plan to mobilize vehicles and equipment for response activities ((installing floating bridges, amphibious vehicles, string guns ...).<br><br>❑ Having backup equipment to ensure smooth communication;<br><br>❑ There is a plan to immediately reach affected people.<br><br>❑ Having equipment (drone etc.) to get necessary information of the disaster affected areas. |

# IV. THINGS TO BE DONE

1. Immediately prevent illegal logging activities (if any);
2. Prepare plans to ensure smooth communication in all situations;
3. Mobilize forces to restore traffic, information system, electricity grids, public works, utilities...
4. Collate data and estimate damages, propose supports and allocate resources appropriately and to right people in need as regulated;
5. Reconstruct after natural disaster adopting "build back better" in association with new rural development; resettlement of relocated people should be associated with sustainable livelihoods and production transformation.

**Mường Lát-Thanh Hóa**

**Mường La -Sơn La**

# THANK YOU!

ADDRESS: BUILDING A4, NO. 2 NGỌC HÀ, BA ĐÌNH, HÀ NỘI
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# INTRODUCTION OF JAPAN TECHNICAL STANDARD FOR DESIGNING COUNTERMEASURES AGAINTS DEBRIS FLOW AND APPLICATION IN VIETNAM

1. Hydraulic Construction Institute (HyCI), Vietnam Academy for Water Resources;
2. Department of Science Technology and International Corporation;
3. MARD JICA experts;
4. Nippon Steel & Sumikin Metal Products Vietnam Co., Ltd.

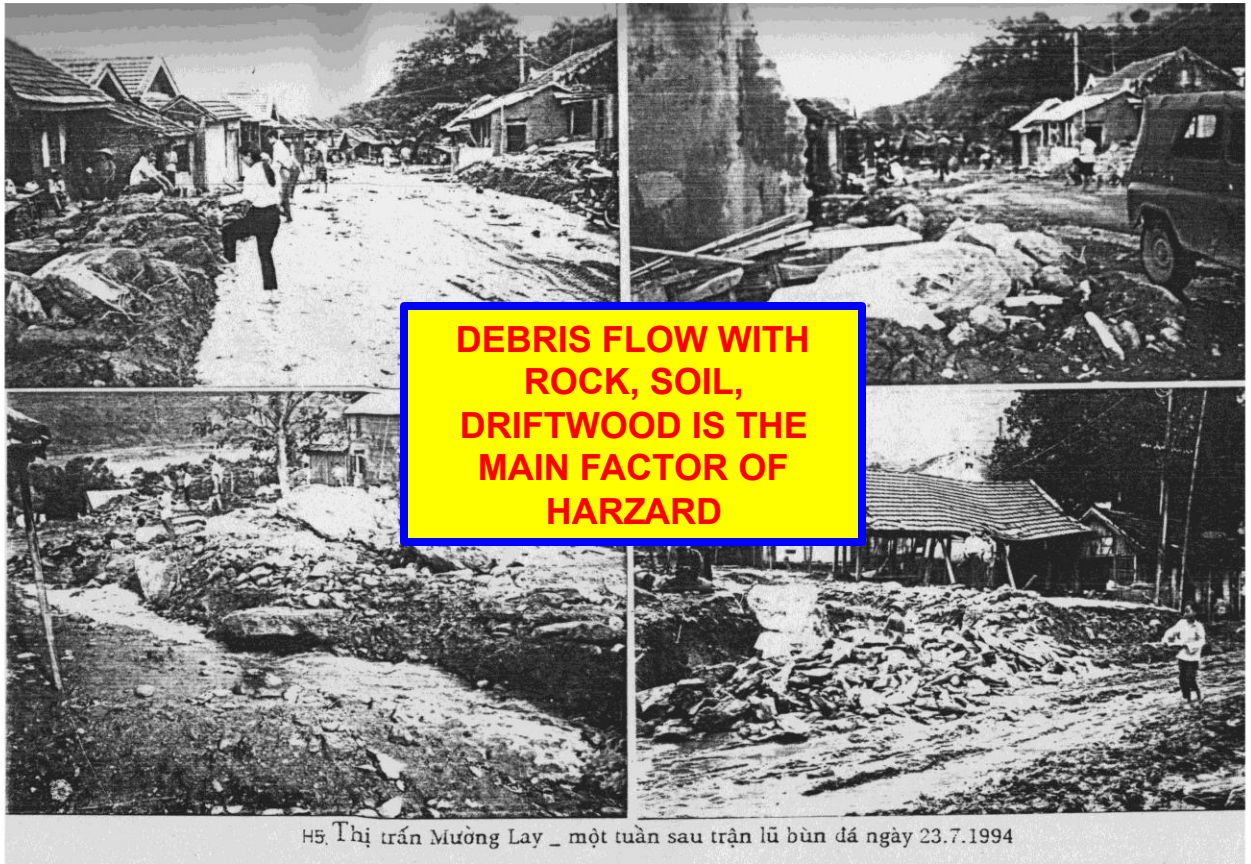
**Dr. Ba Thao VU,**
Head of Department of Geotechnical Engineering, HyCI;
Email: vubathao@gmail.com

# OUTLINE

1. OVERVIEW ON STRUCTURAL COUNTERMEASURES AGAINST DEBRIS FLOWS
2. MAIN CONTENTS OF SABO DESIGN STANDARD
3. APPLICATION OF STANDARD FOR MU CANG CHAI DEBRIS FLOW
4. CONCLUSIONS

# 1. OVERVIEW ON STRUCTURAL COUNTERMEASURES AGAINST DEBRIS FLOWS

# DEBRIS FLOW IN MƯỜNG LAY 1994 ( V.C. MINH)



**DEBRIS FLOW WITH ROCK, SOIL, DRIFTWOOD IS THE MAIN FACTOR OF HARZARD**

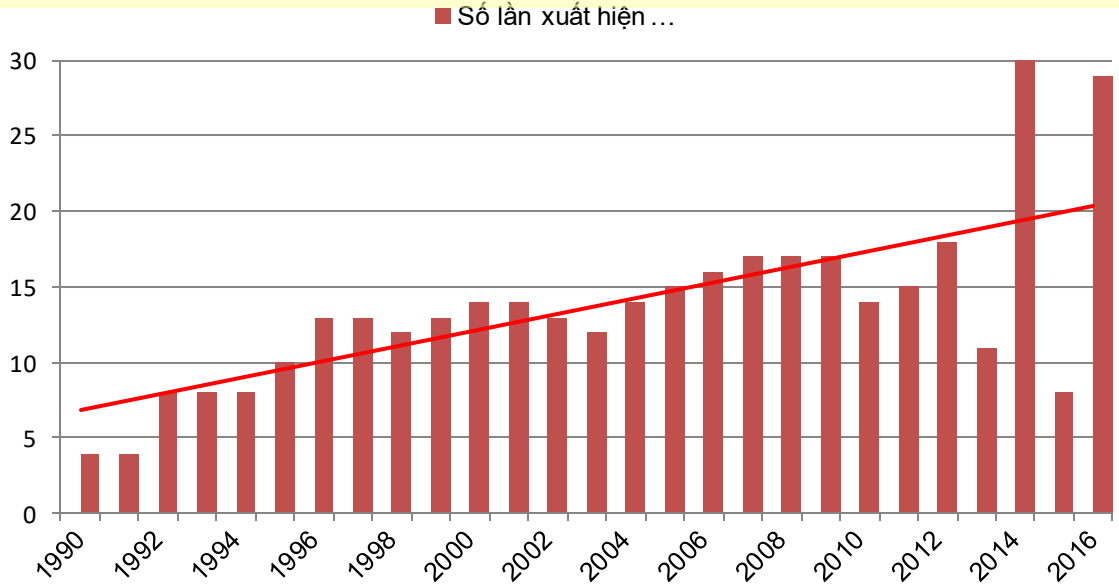
H5. Thị trấn Mường Lay _ một tuần sau trận lũ bùn đá ngày 23.7.1994

## VIETNAM DEBRIS FLOW DISASTERS

In the last 20 years, natural disasters have resulted in about **10.800 people dead or missing** and caused an annual loss of **1.0-1.5% of GDP** (VND 20.000 billion). **Northern mountainous region**: Frequently occurrences of natural disasters such as flash floods, landslides, heavy rainfall, thunderstorms, etc., especially debris flow, flash floods and landslides caused serious damage and tend to increase.

| Year | Dead and missing | | |
|---|---|---|---|
| | By Flash flood, landslides in Northern mountainous | Whole country | Rate % |
| **2014** | 19 | 133 | 15 |
| **2015** | 20 | 154 | 13 |
| **2016** | 31 | 264 | 12 |
| **2017** | 95 | 376 | 25 |
| **Average** | **47** | **375** | **12** |

# NUMBER OF DEBRIS FLOW, LANSLIDE INCREASING




- Debris flow, landslides most often occur in the mountainous and midland provinces in the territory of Vietnam.
- From 2000 to 2016, occurred more than 250 debris flow and landslides
- Density of debris flow and landslides tend to be increasing and intense, especially in 2017.

# PRINCIPLE OF DEBRIS FLOW

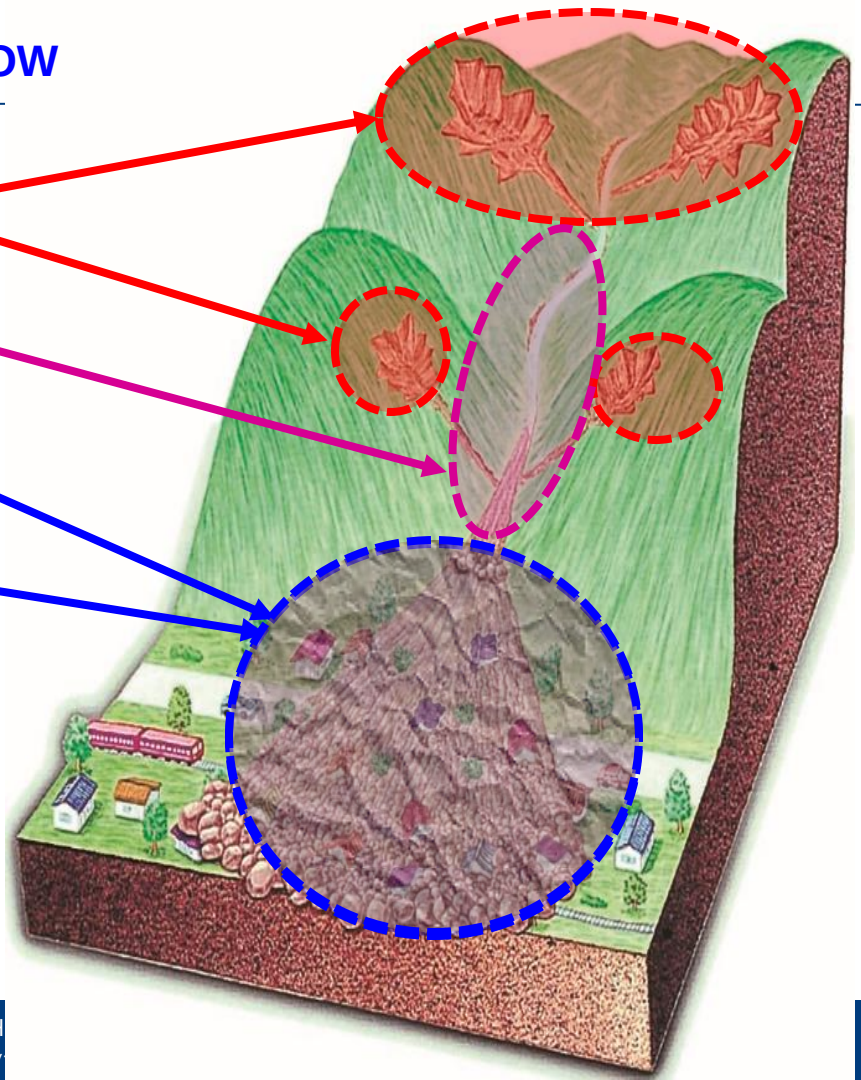
OCCURRENCE AREA

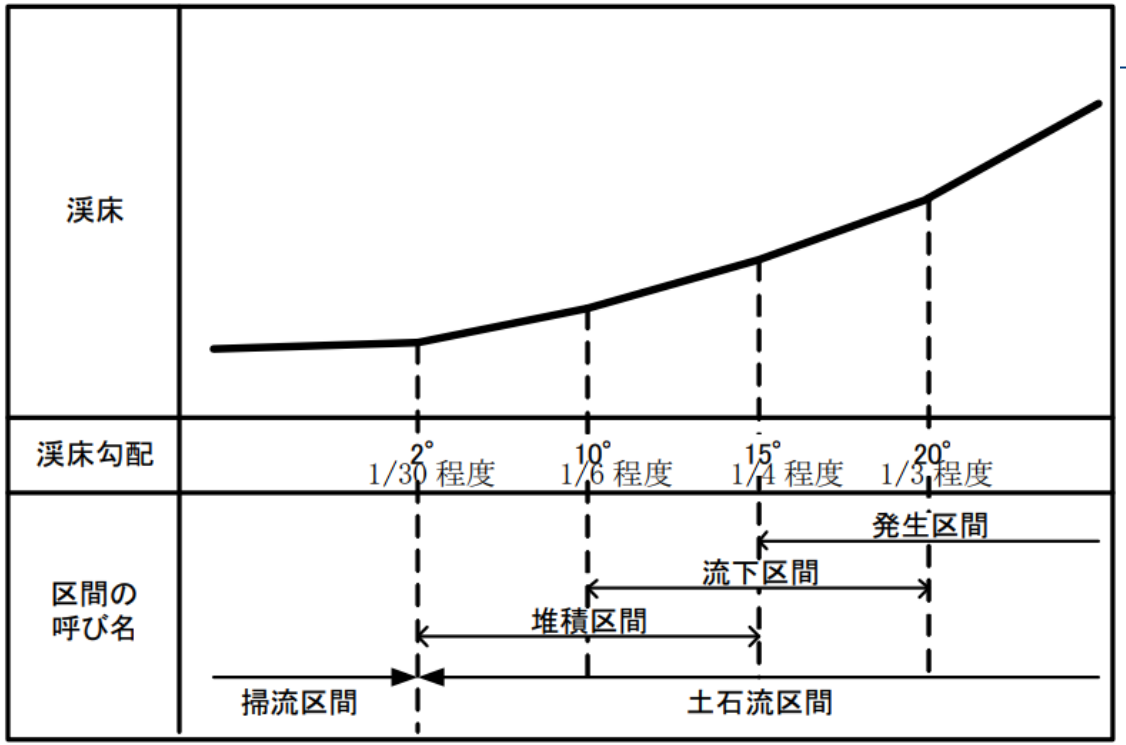
FLOW AREA

DEPOSITION AREA

DISASTER AREA

**DEBRIS FLOW WITH ROCK, SOIL, DRIFTWOOD IS THE MAIN FACTOR OF HARZARD**

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渓床勾配
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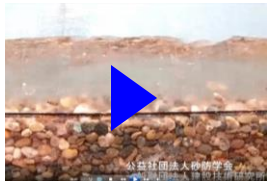
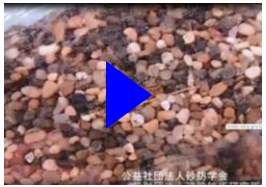
掃流区間
土石流区間





# STRUCTURAL COUNTERMEASURES

**OCCURRENCE AREA**

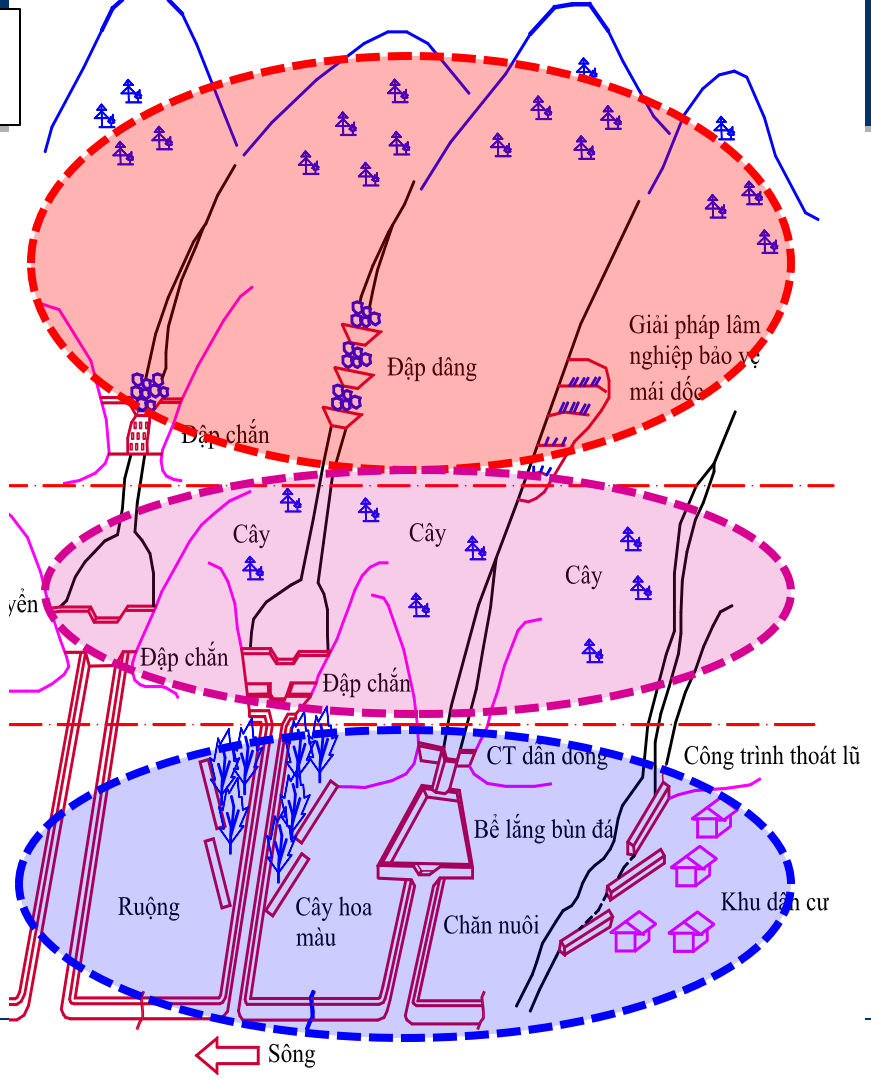
Occurrence and Erosion Control

**FLOW AREA**

Capturing debris flow, Reduce flow energy, Erosion Control

**DEPOSITION AREA**

Capturing debris flow, Sediment Deposition, Direction Control, Guiding debris flow



## OCCURRENCE CONTROL:

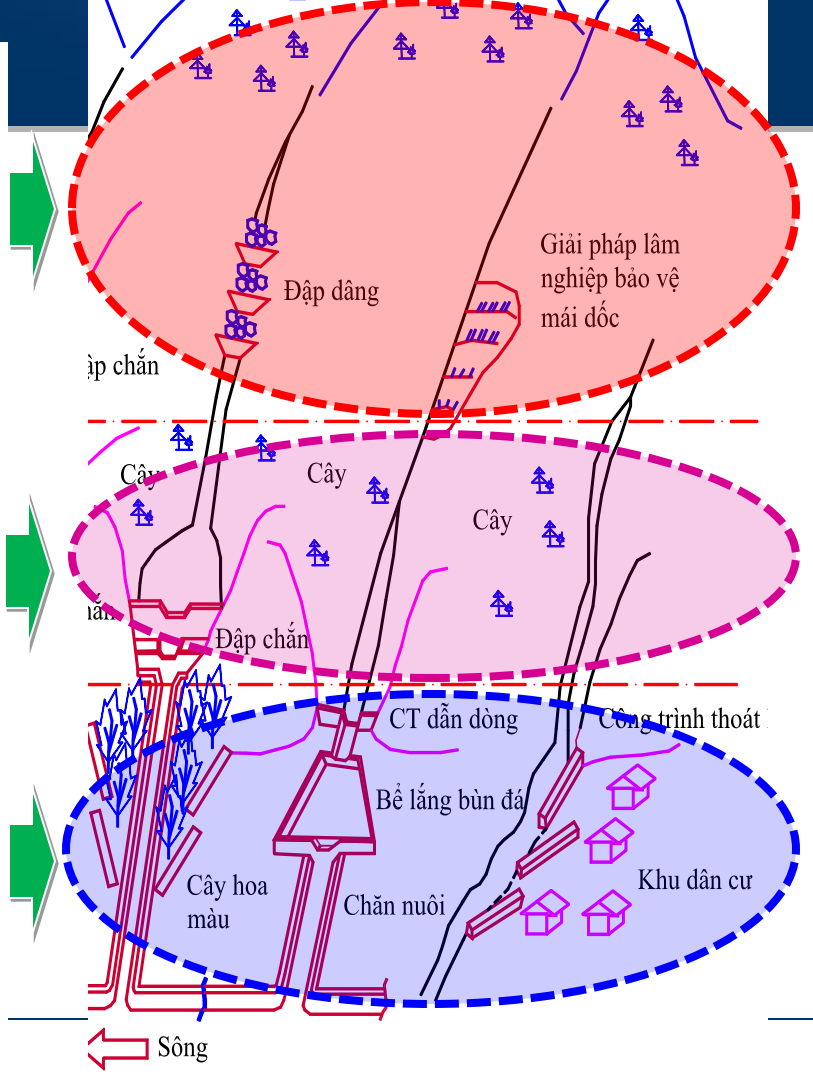
1. Close sabo dams
2. Plants

## FLOWING CONTROL

1. Open or haft-open sabo dams
2. Plants

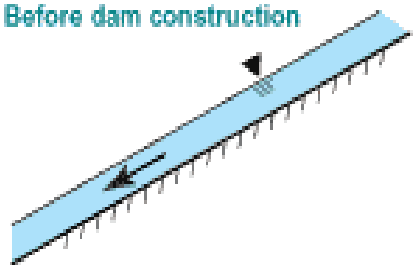
## HAZARD MITIGATION:

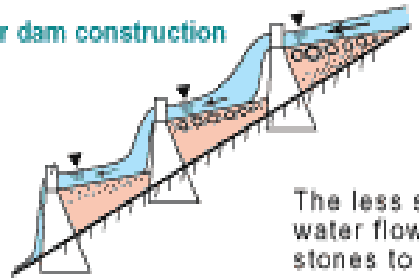
1. Open or haft-open sabo dams
2. Sand pond
3. Chanel work
4. Training wall
5. Forest



# FUNCTIONS OF SABO DAMS

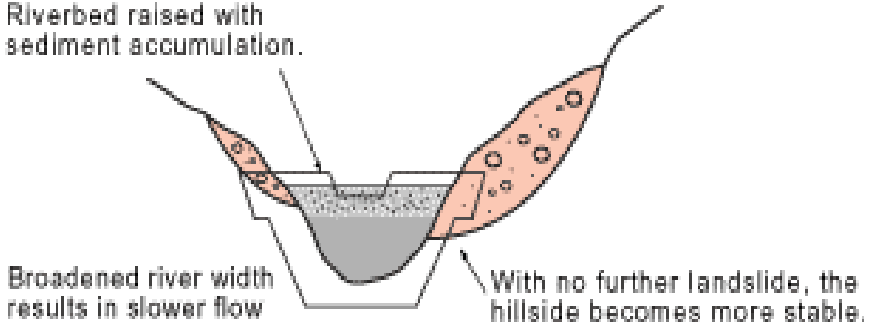
(1) The accumulation of sediment prevents the erosion of the riverbed and also makes the riverbed slope less steep to make the water flow slower




The less steep riverbed makes the water flow slower. This causes larger stones to deposit in the upper stream.

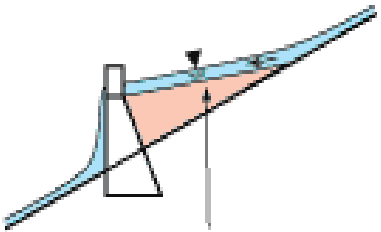
② The riverbed raised by the accumulation of sediment prevents hillside landslide and also makes the river width wider resulting in slower water flow.



# FUNCTIONS OF SABO DAMS

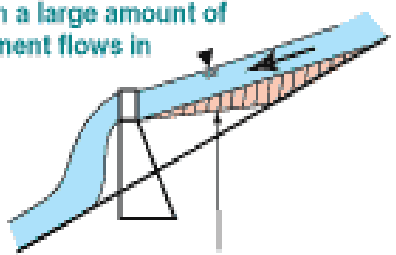
③ The dam prevents a large amount of sediment runoff at a time.

**Before a flood**



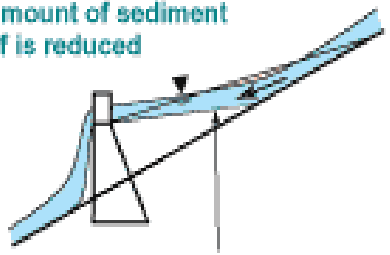
Sediment is accumulated until the space in the upstream side of the sabo dam is filled up with sediment.

**When a large amount of sediment flows in**



The amount of sediment as shown is retained here in case of a large amount of sediment runoff at a time.

**The amount of sediment runoff is reduced**

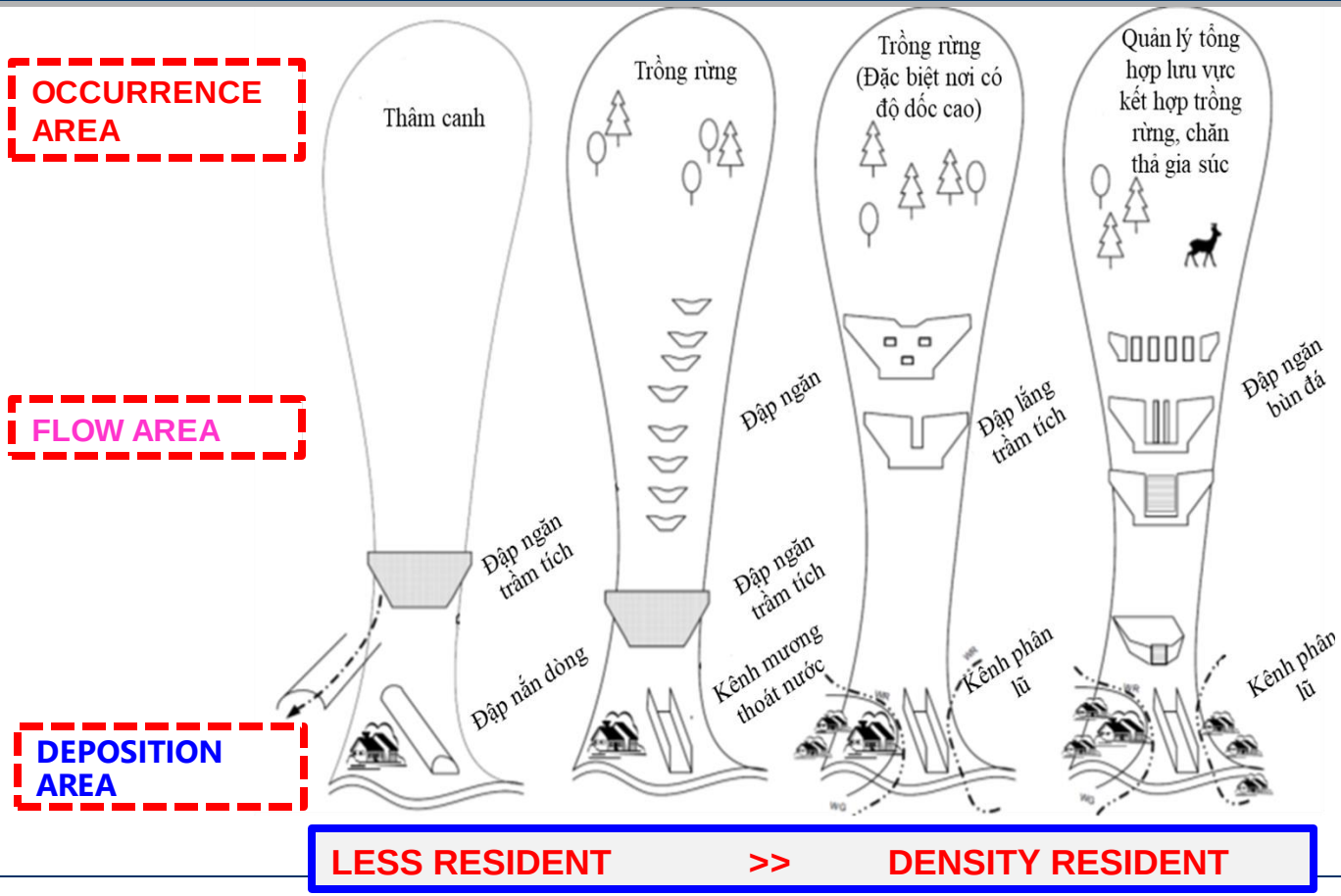


When sediment runoff from the up-stream decreases, the accumulated sediment is carried away to create a space to retain sediment in case of a future large flood.

**A sabo dam prevents riverbed erosion, hillside landslide and a large amount of sediment flow at a time by accumulating sediment in it.**

http://www.sabo-int.org/dott/river.html
http://staff.civil.uq.edu.au/h.chanson/sabo.html

# PLANING OF SABO DAMS BASED ON PROTECTIVE AREA



# EFFECTIVE OF DEBRIS FLOW

EFFECTIVE
OPEN DAM

OPEN TYPE
IS USEFUL
TO CAPTURE
DRIFTWOOD

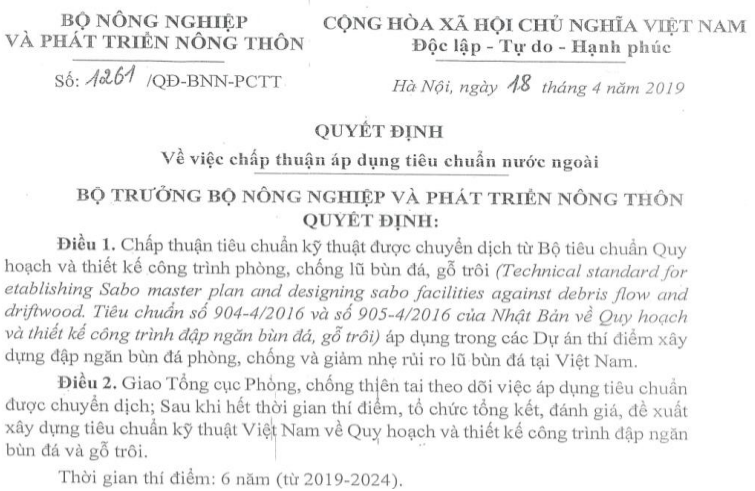
# EFFECTIVE OF DEBRIS FLOW

CLOSED DAM IS NOT GOOD FOR CAPTURING DRIFTWOOD

SIZE OF OPEN TYPE IS TOO LARGE

DEBRIS FLOW CAUSED BY DAM FAILURE

# 2. MAIN CONTENT OF SABO DAM DESIGN STANDARD



BỘ NÔNG NGHIỆP
VÀ PHÁT TRIỂN NÔNG THÔN

Số: 1261 /QĐ-BNN-PCTT

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

*Hà Nội, ngày 18 tháng 4 năm 2019*

**QUYẾT ĐỊNH**

**Về việc chấp thuận áp dụng tiêu chuẩn nước ngoài**

**BỘ TRƯỞNG BỘ NÔNG NGHIỆP VÀ PHÁT TRIỂN NÔNG THÔN**
**QUYẾT ĐỊNH:**

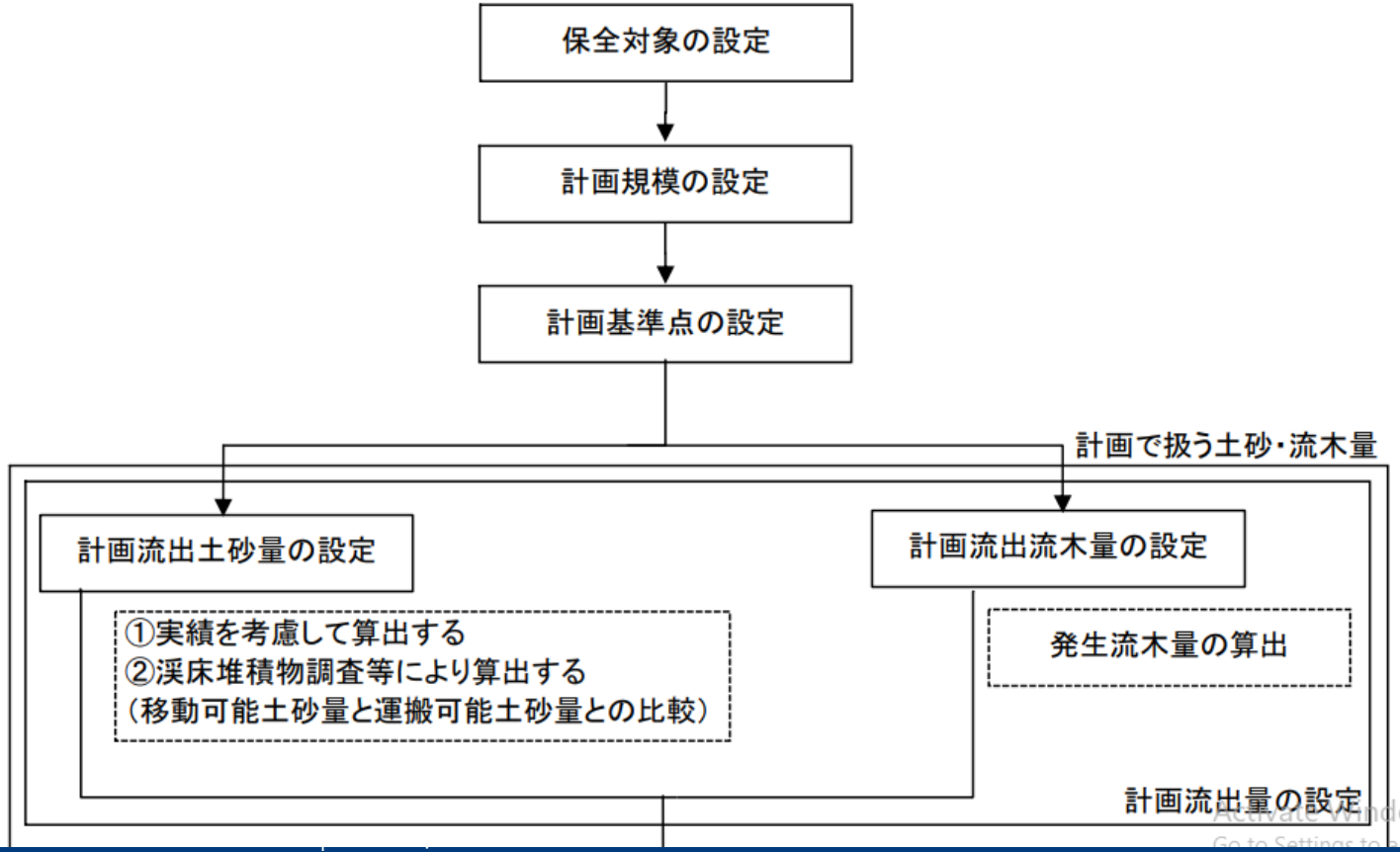
**Điều 1.** Chấp thuận tiêu chuẩn kỹ thuật được chuyển dịch từ Bộ tiêu chuẩn Quy hoạch và thiết kế công trình phòng, chống lũ bùn đá, gỗ trôi *(Technical standard for etablishing Sabo master plan and designing sabo facilities against debris flow and driftwood. Tiêu chuẩn số 904-4/2016 và số 905-4/2016 của Nhật Bản về Quy hoạch và thiết kế công trình đập ngăn bùn đá, gỗ trôi)* áp dụng trong các Dự án thí điểm xây dựng đập ngăn bùn đá phòng, chống và giảm nhẹ rủi ro lũ bùn đá tại Việt Nam.

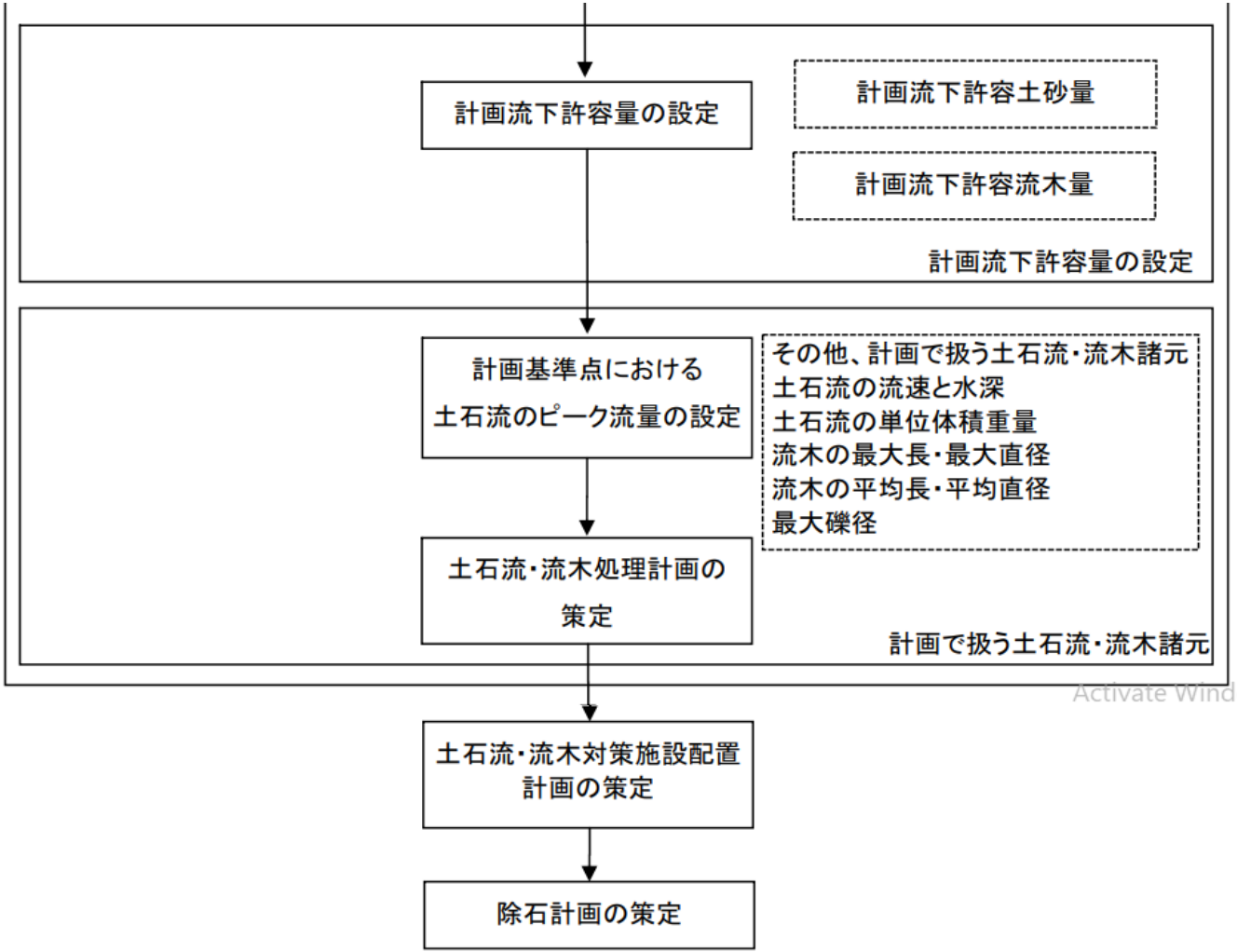
**Điều 2.** Giao Tổng cục Phòng, chống thiên tai theo dõi việc áp dụng tiêu chuẩn được chuyển dịch; Sau khi hết thời gian thí điểm, tổ chức tổng kết, đánh giá, đề xuất xây dựng tiêu chuẩn kỹ thuật Việt Nam về Quy hoạch và thiết kế công trình đập ngăn bùn đá và gỗ trôi.

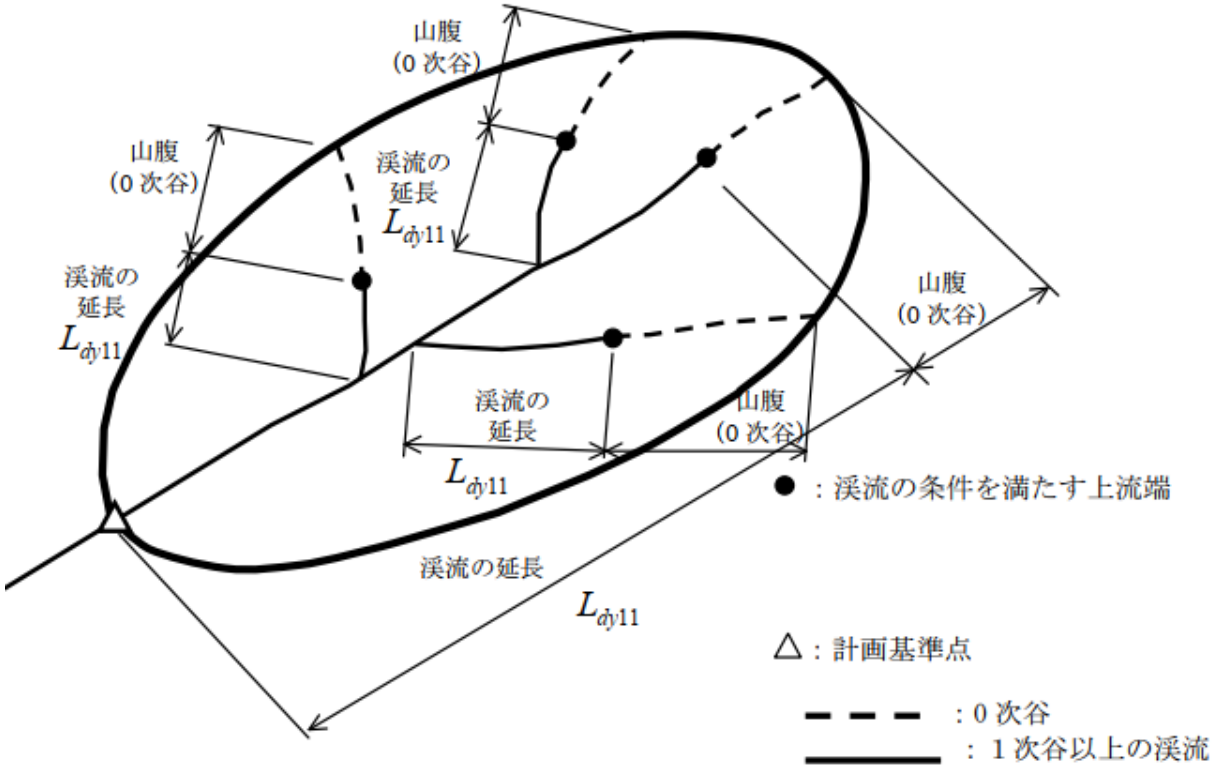
Thời gian thí điểm: 6 năm (từ 2019-2024).

**MARD decided to apply Japan Sabo dam design standard in Vietnam from 2019 to 2024.**

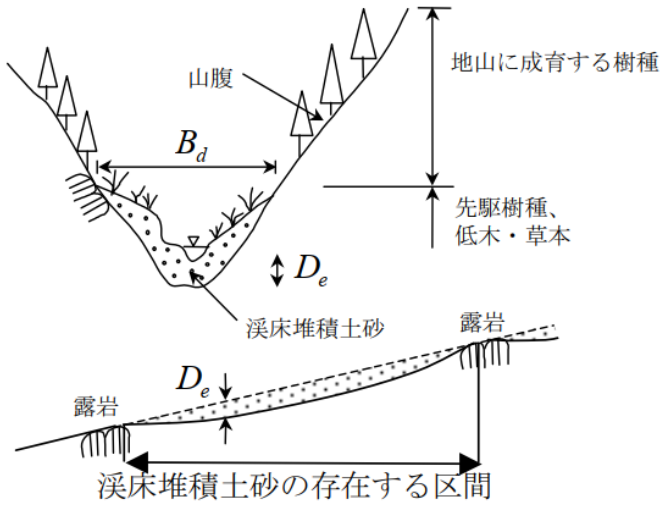
# 土石流・流木対策計画および土石流・流木施設配置計画、除石計画の策定の流れ



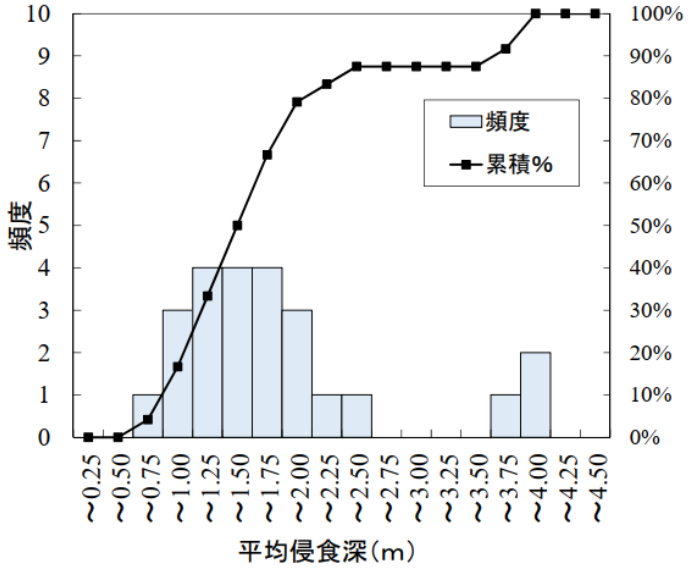




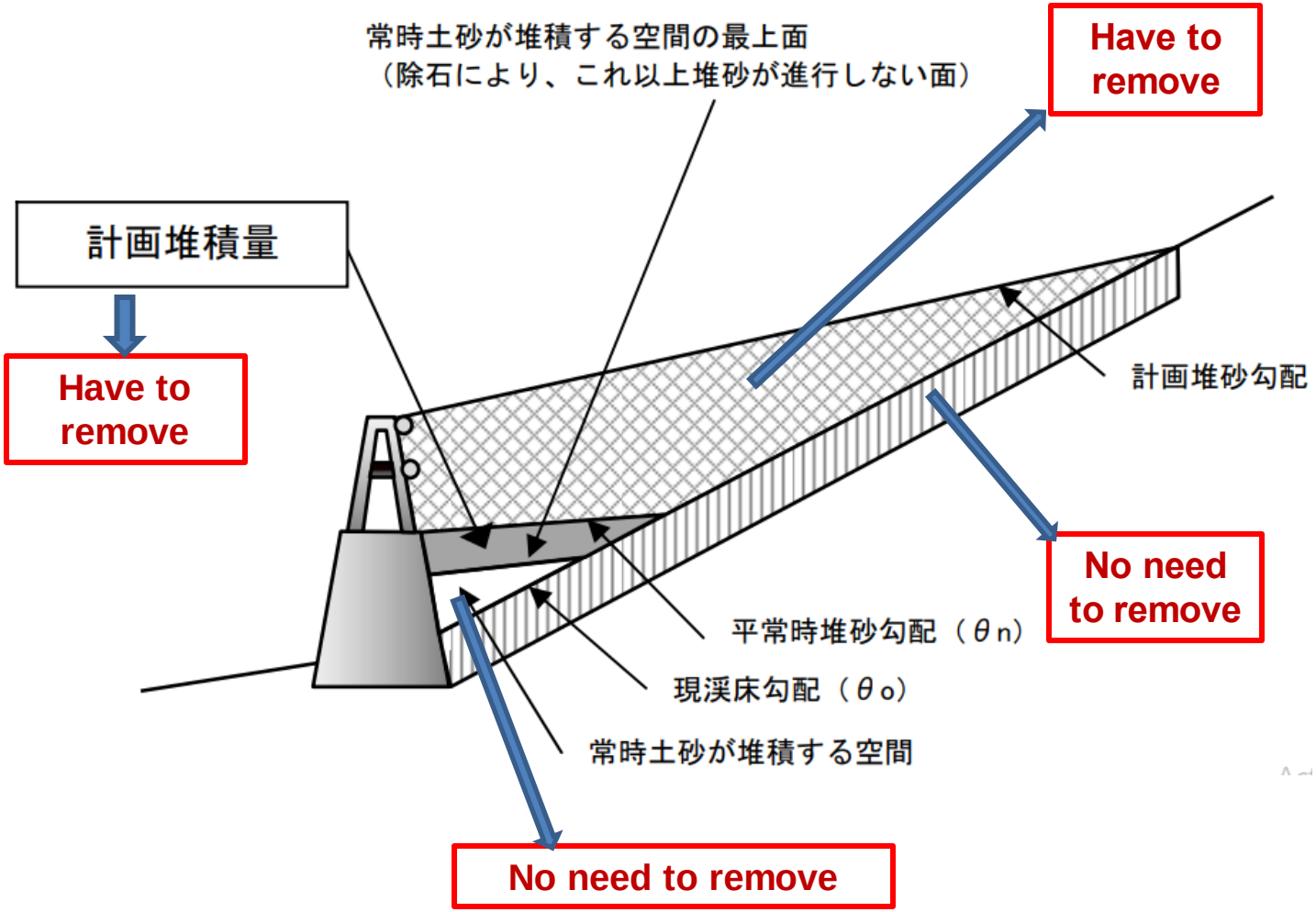

図－３　$L_{dy11}$ のイメージ図

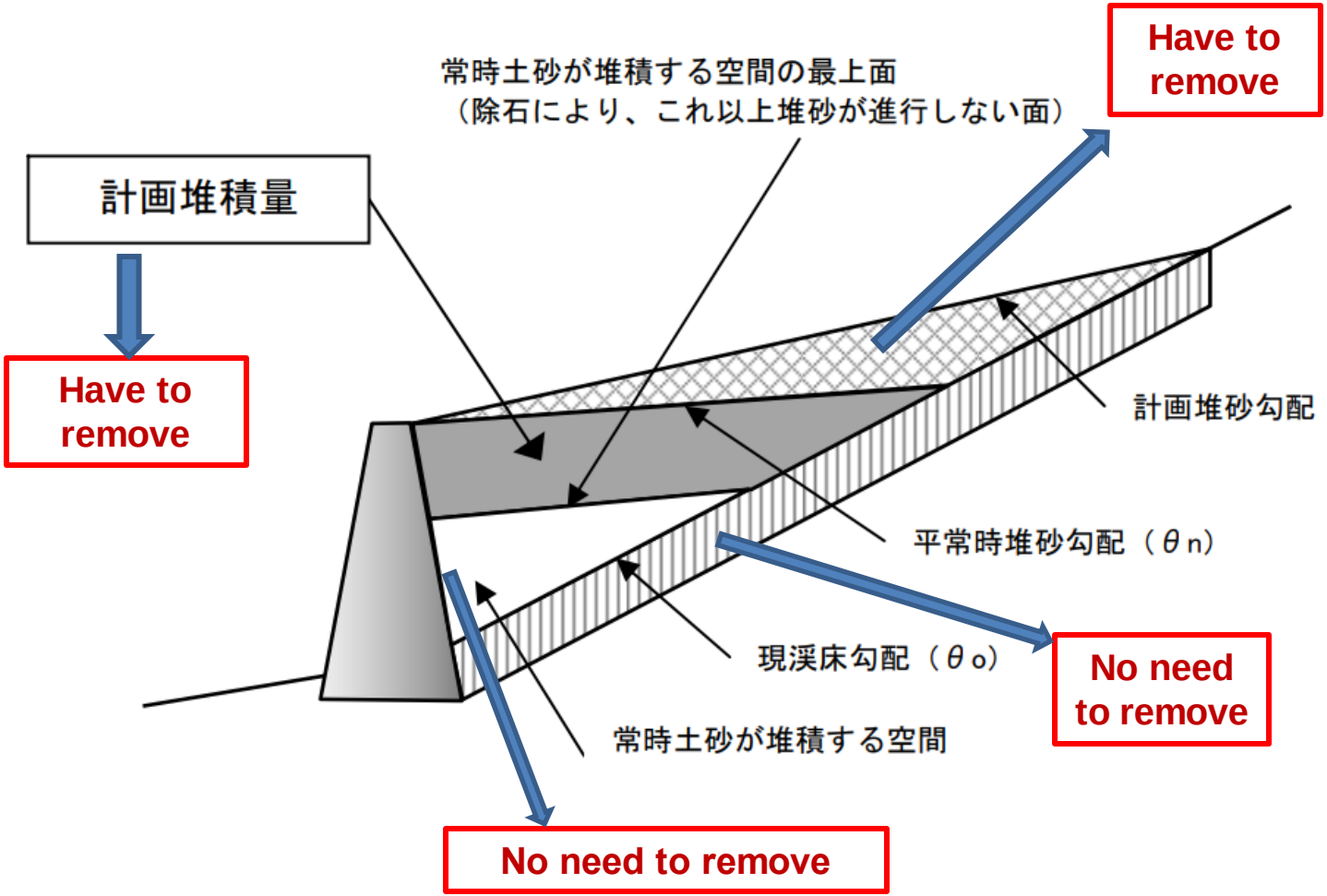



図－４（１）侵食幅、侵食深の調査方法




図－４（２）平均侵食深の分布


常時土砂が堆積する空間の最上面
（除石により、これ以上堆砂が進行しない面）
Have to remove
計画堆積量
Have to remove
計画堆砂勾配
No need to remove
平常時堆砂勾配（θn）
現渓床勾配（θo）
常時土砂が堆積する空間
No need to remove


常時土砂が堆積する空間の最上面
（除石により、これ以上堆砂が進行しない面）
Have to remove
計画堆積量
Have to remove
計画堆砂勾配
平常時堆砂勾配（θn）
現渓床勾配（θo）
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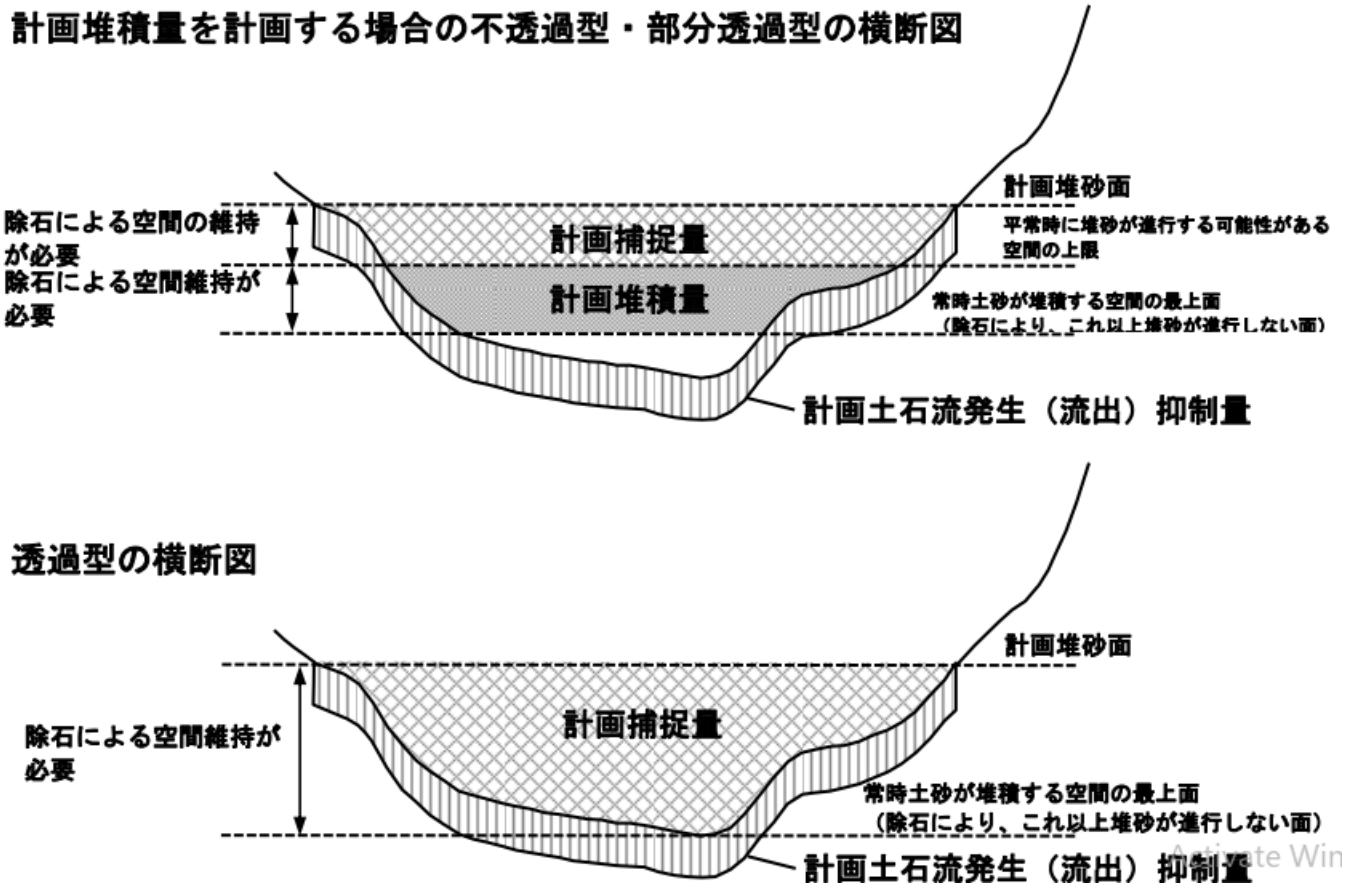
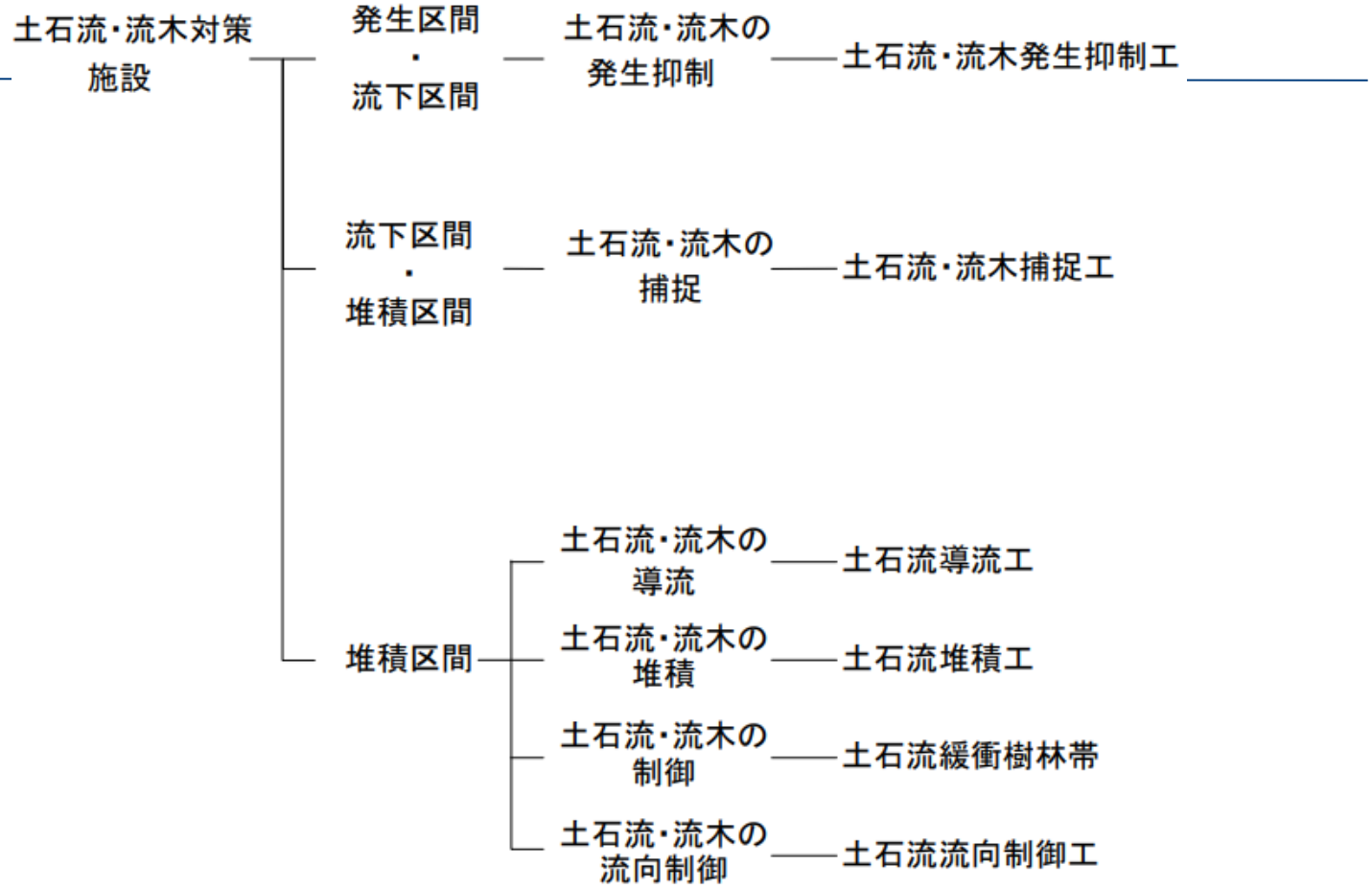
常時土砂が堆積する空間
No need to remove




図－１９（１）　砂防堰堤の型式別の計画で扱う土砂・流木量等




図－１８　土石流・流木対策施設の種類

# Case study


Structural and nun-structural countermeasures for a debris flow area in Taiwan

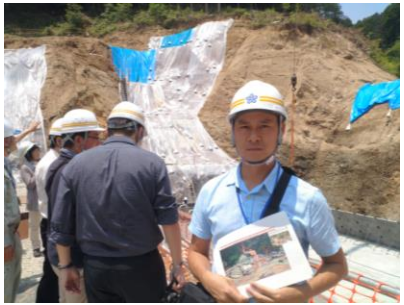
# 3. APPLICATION OF SABO DESIGN STANDARD FOR DEBRIS FLOW IN MU CANG CHAI, YEN BAI PROVINCE

1. Dr. Vu Ba Thao, Hydraulic Construction Institute, VAWR, VIETNAM
2. Dr. Akihiko IKEDA, Sabo & Landslide Technical Center, JAPAN

# Recent activities on application of sabo standards

Field survey on debris flow in Tokyo, June 2019

Closed dam, channel works behind the dam are needed, Kyushu, June 2019



Visiting a closed dam in Kyushu, June 2019

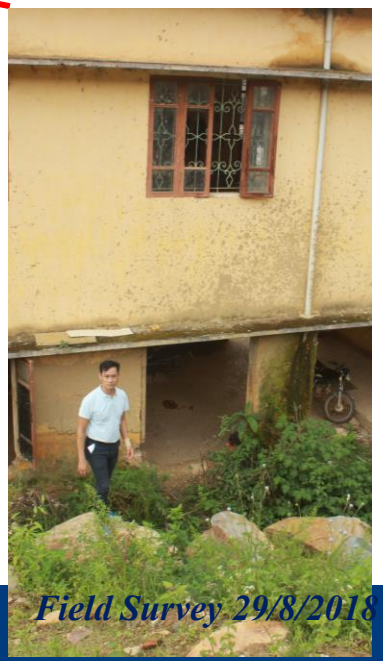
Closed dam was repaired to be an open dam for capturing more driftwood

Debris flow model test at Kyushu University

A large open sabo dam in Kyushu

# (1) Outline of 2017 debris flow

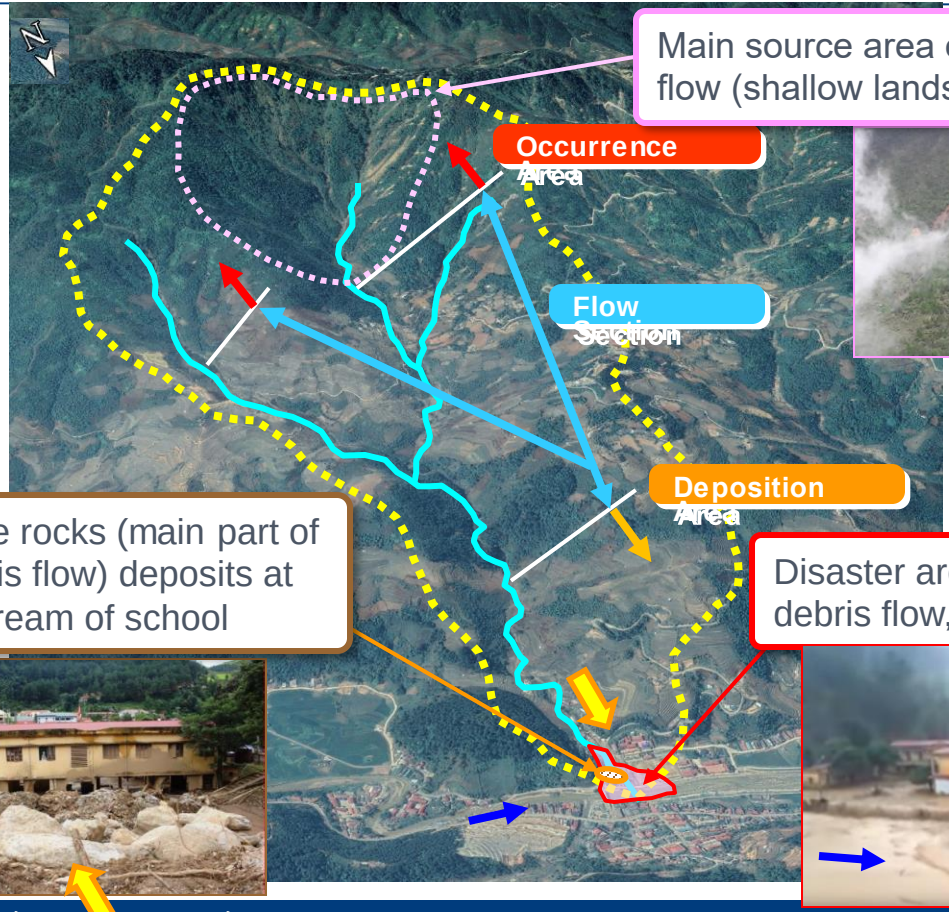
Location: MCC dist., Yen Bai province
Date: 4 a.m. 2/8/2017
Damage: 15 dead and missing, 279 houses collapsed and destroyed, road and bridge seriously damaged
Trigger: *Rain*



*Field Survey 29/8/2018*

# (1) Outline of 2017 debris flow

# (1) Outline of 2017 debris flow




Main source area of debris flow (shallow landslide)

Huge rocks (main part of debris flow) deposits at upstream of school



Disaster area (muddy debris flow, driftwood)

# (1) Outline of 2017 debris flow

3 August 2017

2019

# (2) Recent Condition of Catchment

Occurrence/Source (slope/hillside) area of debris flow (shallow landslide)

- The surface of shallow landslides are covered with vegetation.
- Depth of landslides are approximately 0.5m-1.0m.
- Base rock of the landslides are weathered.
- Landslide soils are not remained at the foot of landslides. It may flushed toward downstream by the debris flow.

# (2) Recent Condition of Catchment

Flow section (river course) of debris flow

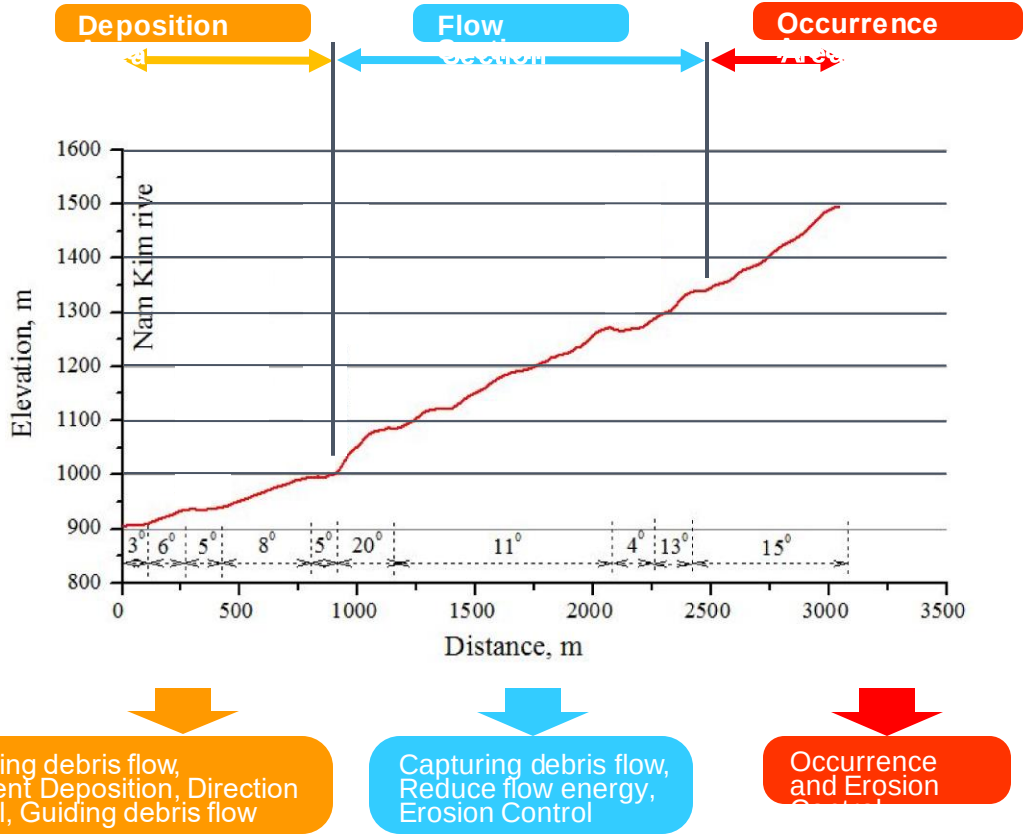
- River bank has been eroded by the debris flow, but the erosion depth is small (base rock are exposed).
- Debris flow deposit are remained in the riverbed.
- Base rock are locally exposed at the riverbed, sometime it forms a fall.
- Trace of the debris flow is not so high. The peak discharge of debris flow maybe depend on the volume of landslides.

# (2) Recent Condition of Catchment

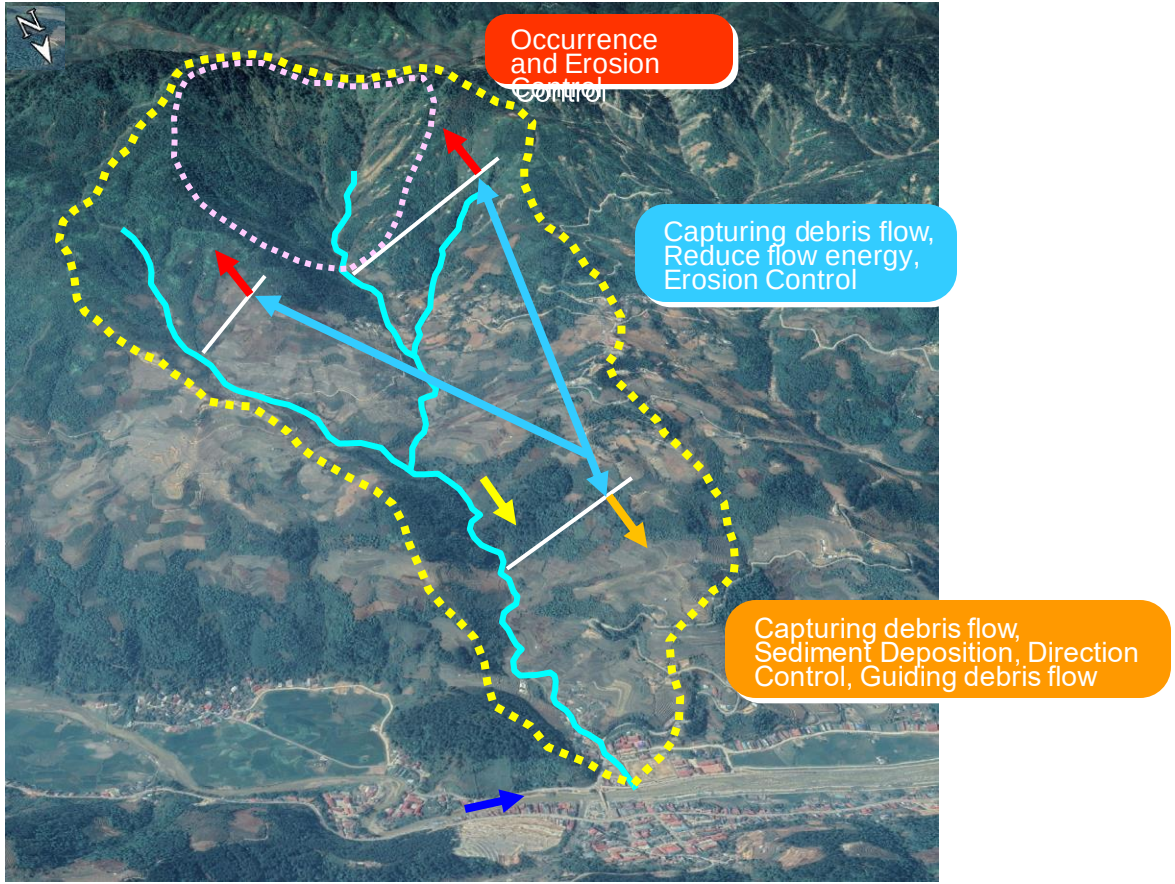
Deposition area (alluvial fan) of debris flow

- Debris flow deposit are removed, while locally remained in and around the river.
- Cross section of the channel do not have the enough capacity for the debris flow peak discharge.
- School that locates on the right bank must be protected from the debris flow. This school can be used for the evacuation facility for the debris flow (not for the flood of the main stream).

# (3) Policy of Sediment Control Plan



# (3) Policy of Sediment Control Plan



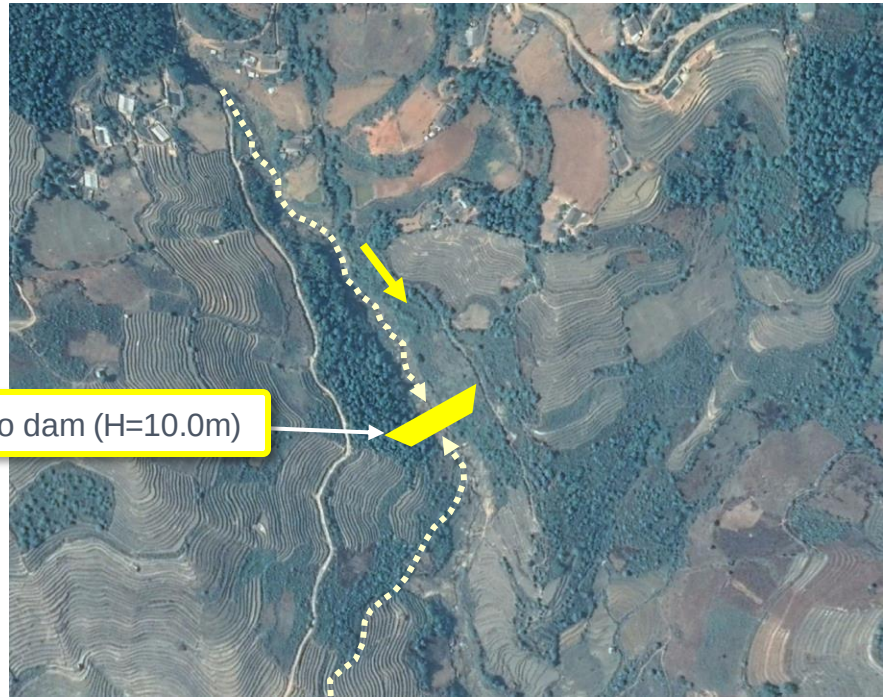
# (4) Countermeasure Facilties Plan


If possible (2nd Stage) ;
Close type sabo dam (H=10.0m)
- Source of debris flow is the landslide, capture as possible

Close type sabo dam (H=5.0m)

Close type sabo dam (H=5.0m)

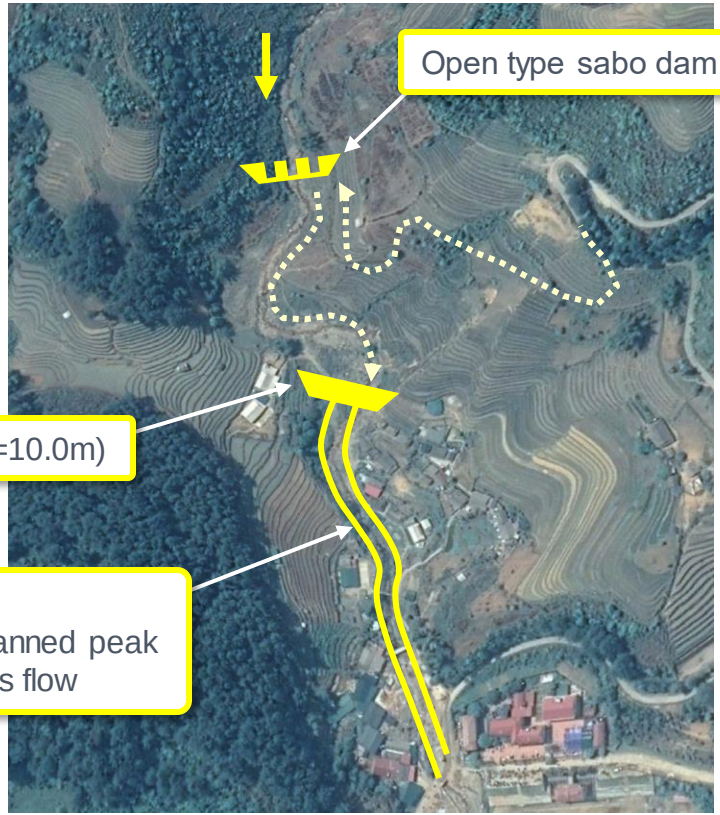
# (4) Countermeasure Facilties Plan

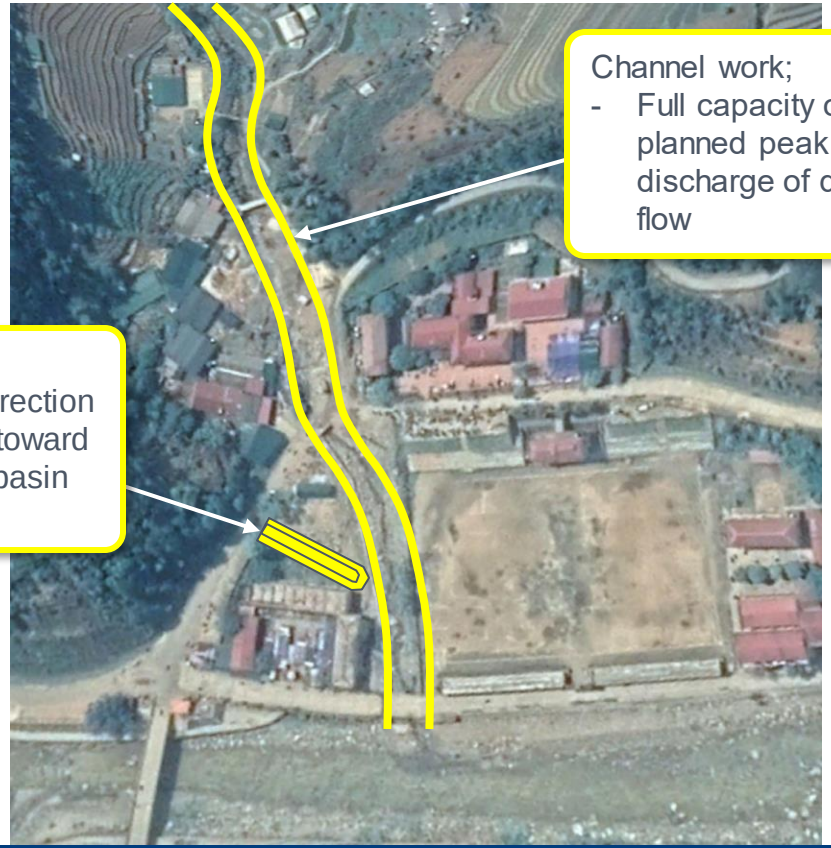
# (4) Countermeasure Facilties Plan

DIFFICULT TO CONSTRUTION
- Flow section of debris flow
- River is narrow and steep
- No road to access the river

# (4) Countermeasure Facilties Plan

# (4) Countermeasure Facilties Plan



Channel work;
- Full capacity of planned peak discharge of debris flow

Training dyke;
- Change the direction of debris flow toward the sediment basin (left bank)

# 4. CONCLUSION

- Unlike flooding, flash floods on rivers, the debris flow occurs at valleys/streams with great destructive power, in which rock, mud and driftwood are the main factors causing disasters on infrastructure, people and properties. Rock, mud and driftwood must be controlled to minimize damage.
- The sabo dam prevents riverbed erosion, hillside landslide and a large amount of sediment flow at a time by accumulating sediment in it.
- According to the experiences of many foreign countries such as US, Austria, Italy, Japan, China, Indonesia, Malaysia, Sri Lanka, etc., the sabo dam is the most effective countermeasure to prevent and mitigate the damage caused by debris flow, but not yet applied in Vietnam due to limited economic, technical, cognitive, etc.
- Vietnam MARD had been decided to apply Japan Sabo dam design standard in Vietnam from 2019 to 2024.

# *Thank you!*

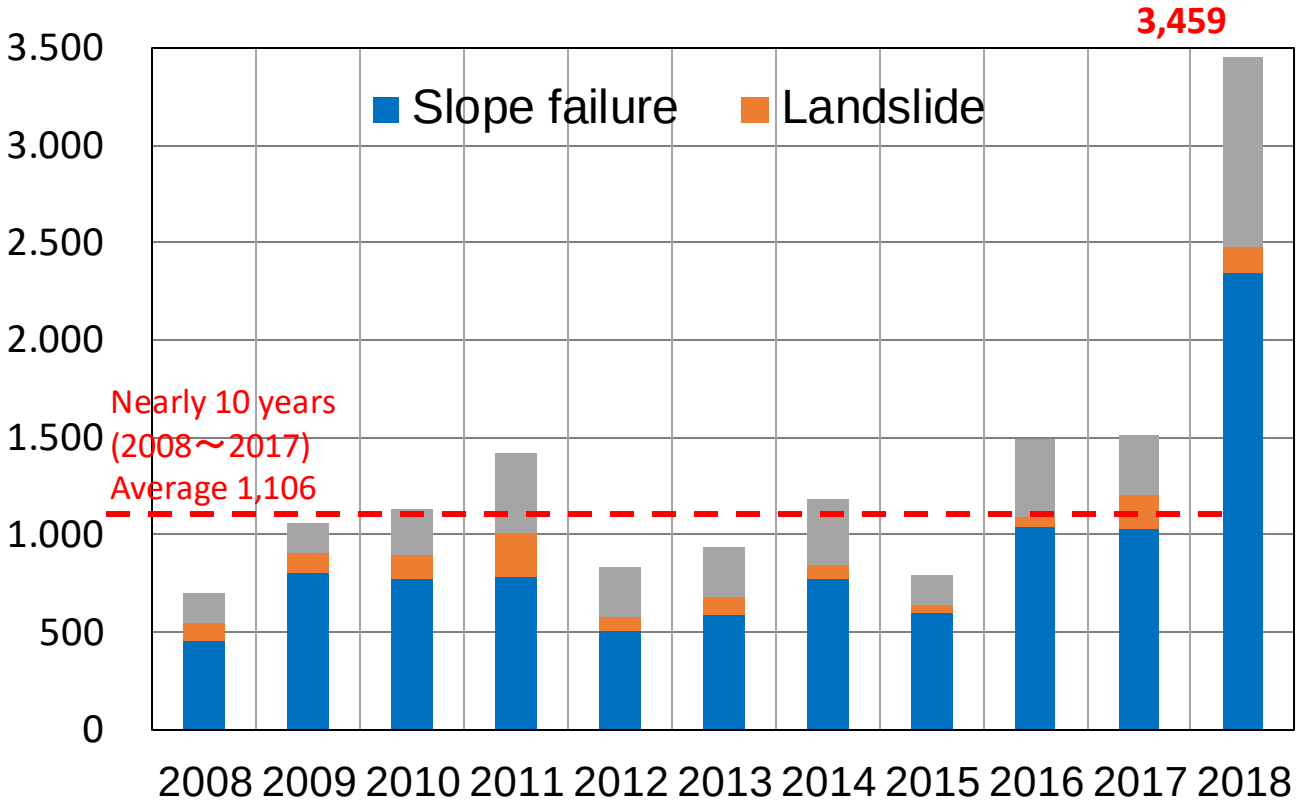
# Outline of Measures for sediment disaster in Japan (Especially for debris flow countermeasures)

October 11, 2019

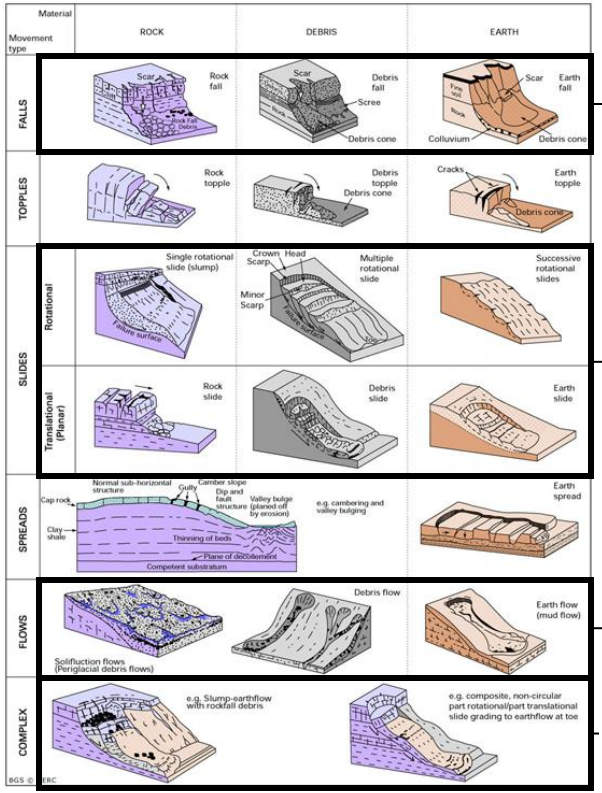
IMAMORI Naoki
Sabo Planning Division, Sabo Department
Water and Disaster Management Bureau
Ministry of Land, Infrastructure, Transport and Tourism

# introduction

# Sediment disasters in Japan in recent years



## Cruden and Varnes, 1996




## Classification of sediment disasters in Japan

**Slope Failure**

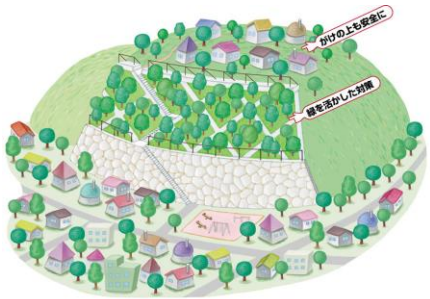
**Landslide**

**Debris Flow**

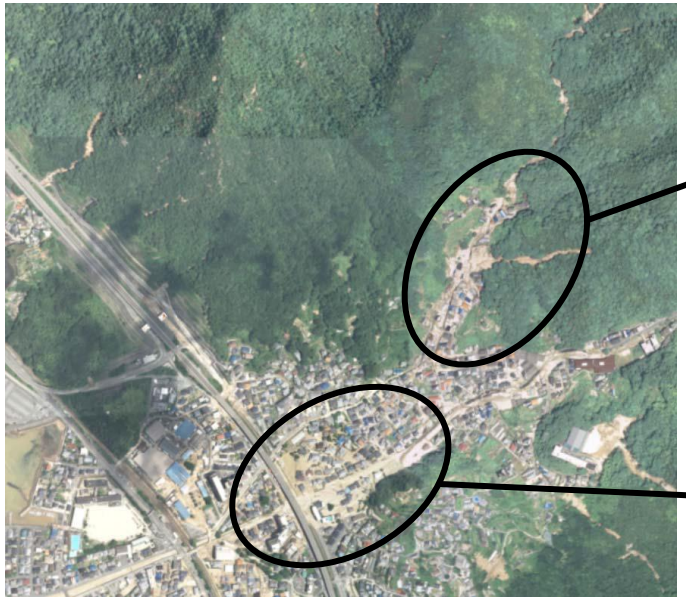
# Why do we classify it in this way?

- Different appropriate measures should be respectively taken to prevent the disasters caused by each one of those phenomena.
- Japanese classification comes from disaster prevention-oriented approach.

| Debris Flow | Landslide | Slope Failure |
|---|---|---|
| Measures such as catch dams or debris basins are taken to catch the debris flow. | Measures such as groundwater drainage, anchors are taken to stabilize a slope. | Measures such as retaining wall are taken to retain a soil to a slope. |

- In 2018, a landslide that caused enormous damage occurred in Hiroshima Prefecture. More than 80 people died.
- In the upstream region, many debris flows occurred, and the sediment that flowed into the river was carried downstream and accumulated.
- As a result, flooding occurred downstream, causing a combination of sediment and flood disasters.

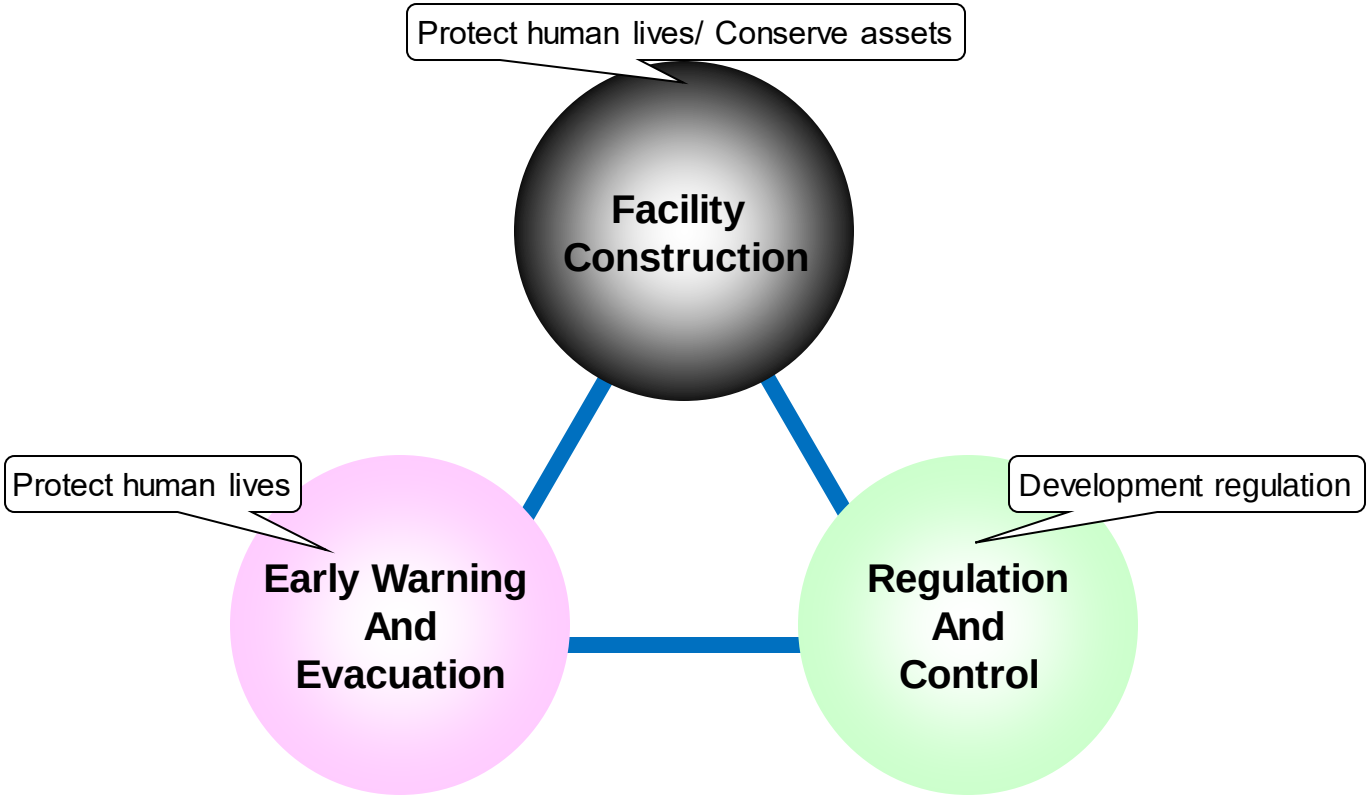


Damage caused by debris flows

Damage caused by debris floods

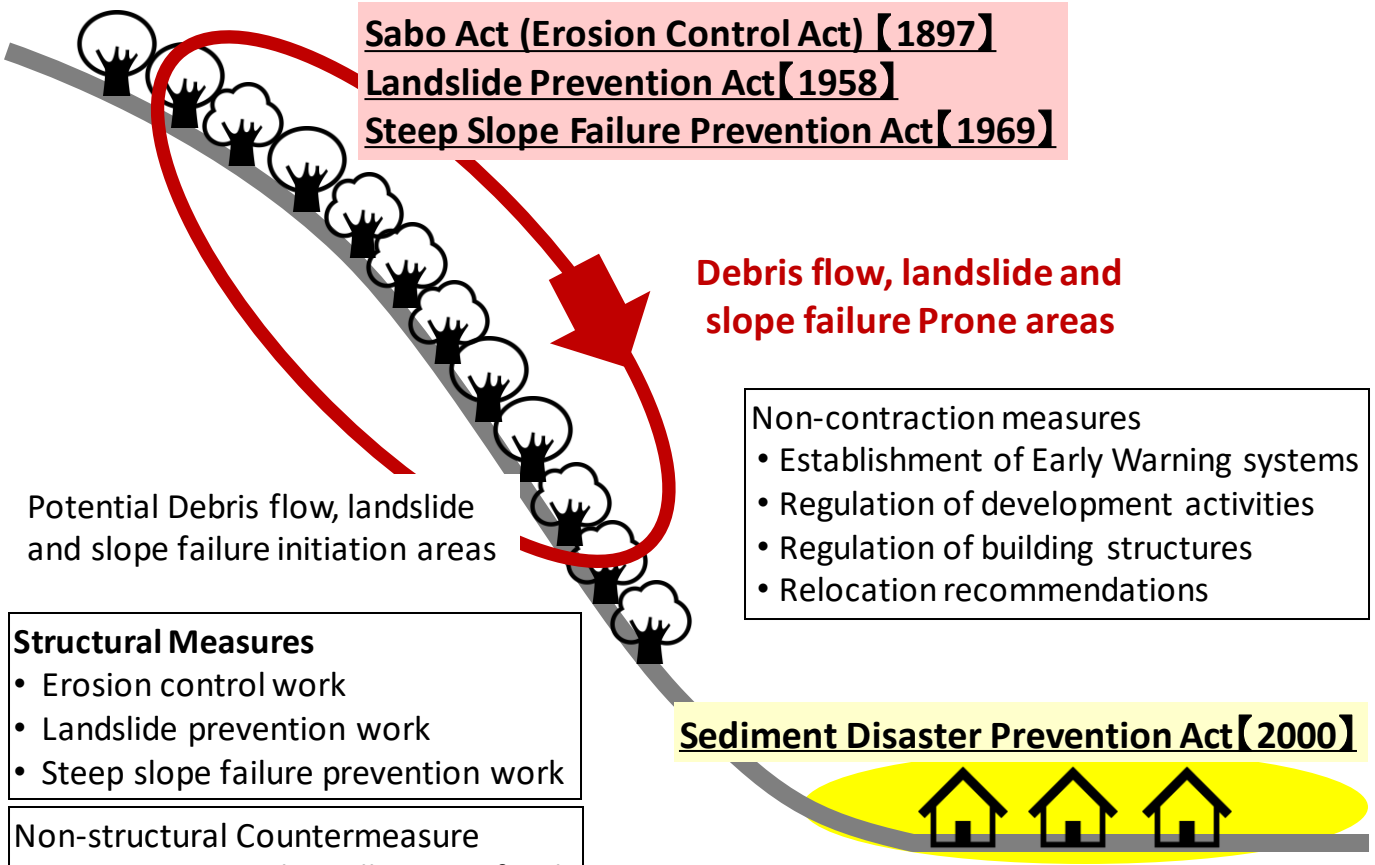
# Laws, organization and budget for sediment disaster reduction in Japan

# Three main actions for Sediment Disaster Reduction




Non structural measures

# Four acts concerning Sediment Disaster Reduction



# Laws related to disaster risk management

**Other ministries**

- Disaster Countermeasures Basic Act
- Act on Special Measures concerning Countermeasures for Large-scale Earthquakes
- Act on Special Measures against Tokyo Inland Earthquake
- Act on Special Measures for Active Volcanoes
- Fire Service Act
- Disaster Relief Act
- Act on Special Financial Support to Deal with the Designated Disaster of Extreme Severity

etc.

**MLIT**

国土交通省

**Sabo Department**

- Sabo Act
- Landslide Prevention Act
- Steep Slope Failure Prevention Act
- Sediment Disaster Prevention Act

- River Act
- Act on Specified Multipurpose Dams
- Coast Act
- Flood Control Act
- Building Standards Act
- City Planning Act
- Meteorological Service Act

etc.

**Ministry of Land, Infrastructure, Transport and Tourism (MLIT)**

- Sabo Department
  - Sabo Planning Division
  - Land Conservation Division
- Regional Development Bureau (9) — Office (40*)
- National Institute for Land & Infrastructure Management (NILIM) — Sabo Department

**Prefectures (47)**

- Public Works Department
  - Sabo Division
  - Branch Office

**Public Works Research Institute (PWRI)** — Sediment Control Research Group

-*Works for sediment disasters

## Annual budget regarding Sabo projects : about 310 billion JPY (approx. 2.3 billion USD)

| | | |
|---|---|---|
| MLIT Budget | 150 billion JPY | |
| | National govt. expenditure | 66.7% |
| | Prefecture burden | 33.3% |

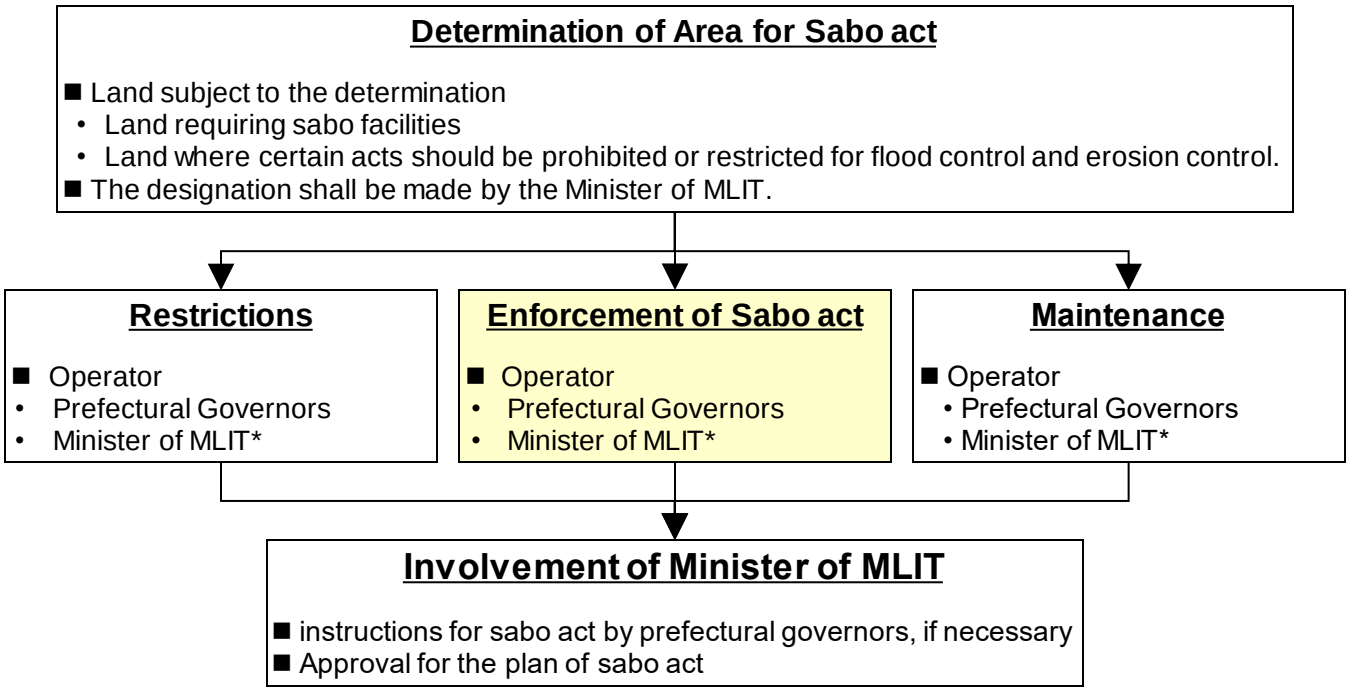
**For MLIT's direct implementation**

| | | |
|---|---|---|
| Prefecture (47) Budget | 160 billion JPY | |
| | Prefecture expenditure | 50% |
| | National govt. subsidy | 50% |

**Subsidized to Prefectures from MLIT**

-2019 Japanese Fiscal Year

- Execution of sabo act is an obligation of prefectures.
- The national government can also implement the sabo act if the interests of more than two prefectures are involved.

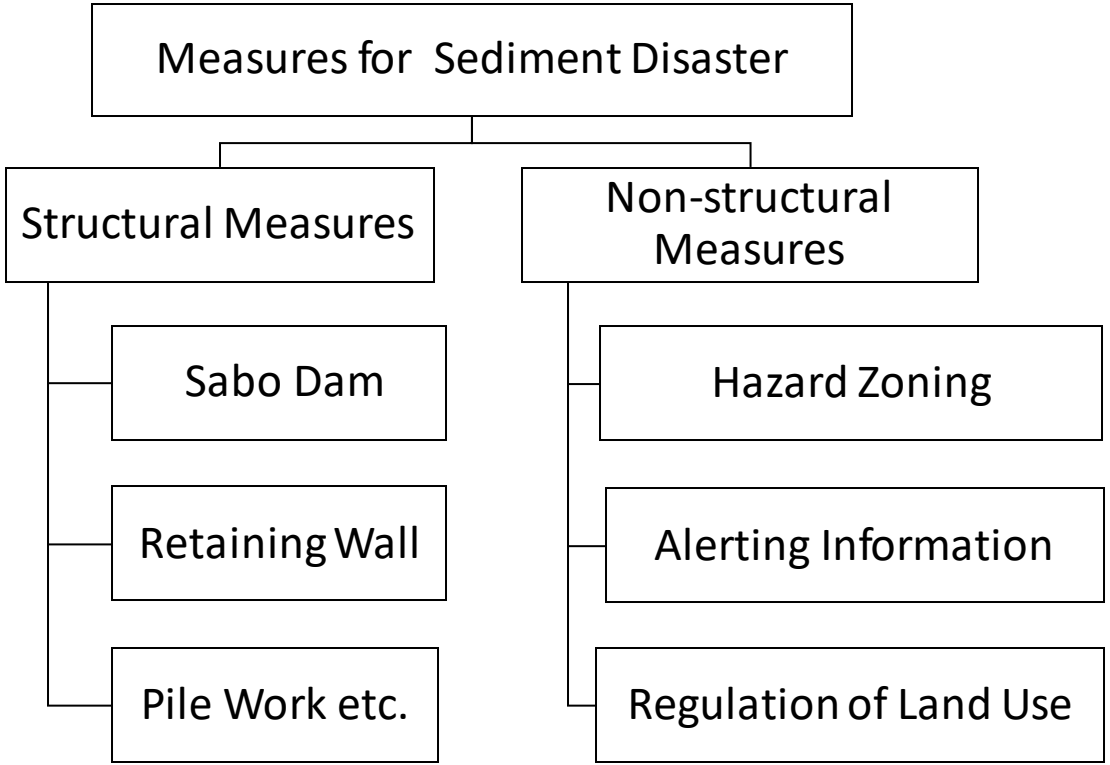



*Cases in which interests are not limited to one prefecture , etc.

# Structural measures
# and
# Non structural measures

# Basic Framework of Measures for Sediment Disaster

Basic Framework Established in 1969 in Japan



# History of Sediment Disaster Management Improvement




1966: Disaster (Yamanashi Prf.)

1966: Introduced Non-structural Measures

1967: Disaster (Hyogo Prf. etc.)

1969: Introduced Rainfall Criteria for Evacuation (Uniform Criteria although the Nation)

1971-72: Disaster (Kagoshima)

1972: Established resettlement Support Program

1972-76: Disaster (Shizuoka Prf. etc.)

1977: Started Installation of Debris Flow Prone Torrent Signboard

1982: Disaster (Nagasaki Prf.)

1984: Developed Landslide Prediction Method

# History of Sediment Disaster Management Improvement




1999: Disaster (Hiroshima Prf.)

2000: Enacted Sediment Disaster Prevention Act. Pref. Governor was legally obliged to investigation to designate Sediment Disaster Alert Areas.

2004: Disaster (Niigata Prf.)

2005: Amended Sediment Disaster Prevention Act. Mayor was to disseminate Hazard Maps.

2014: Disaster (Hiroshima Prf.)

2014: Amended Sediment Disaster Prevention Act. Pref. Governor was obliged to disseminate Sediment Disaster Alert etc.

- Sediment Disaster Prevention Law has been enforced as of April 1, 2001.
- Further promotion is needed to designate all hazardous areas , in addition to cooperation by municipalities.

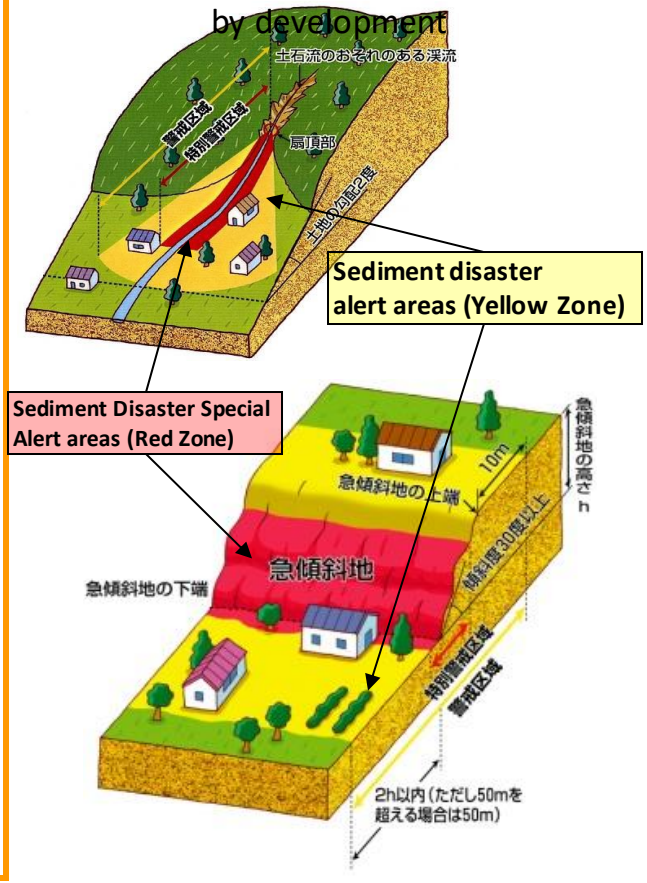
## Designation of sediment disaster alert areas (Yellow)

- Strengthening information sharing and warning and evacuation system
- Informing residents of relevant points of warning and evacuation

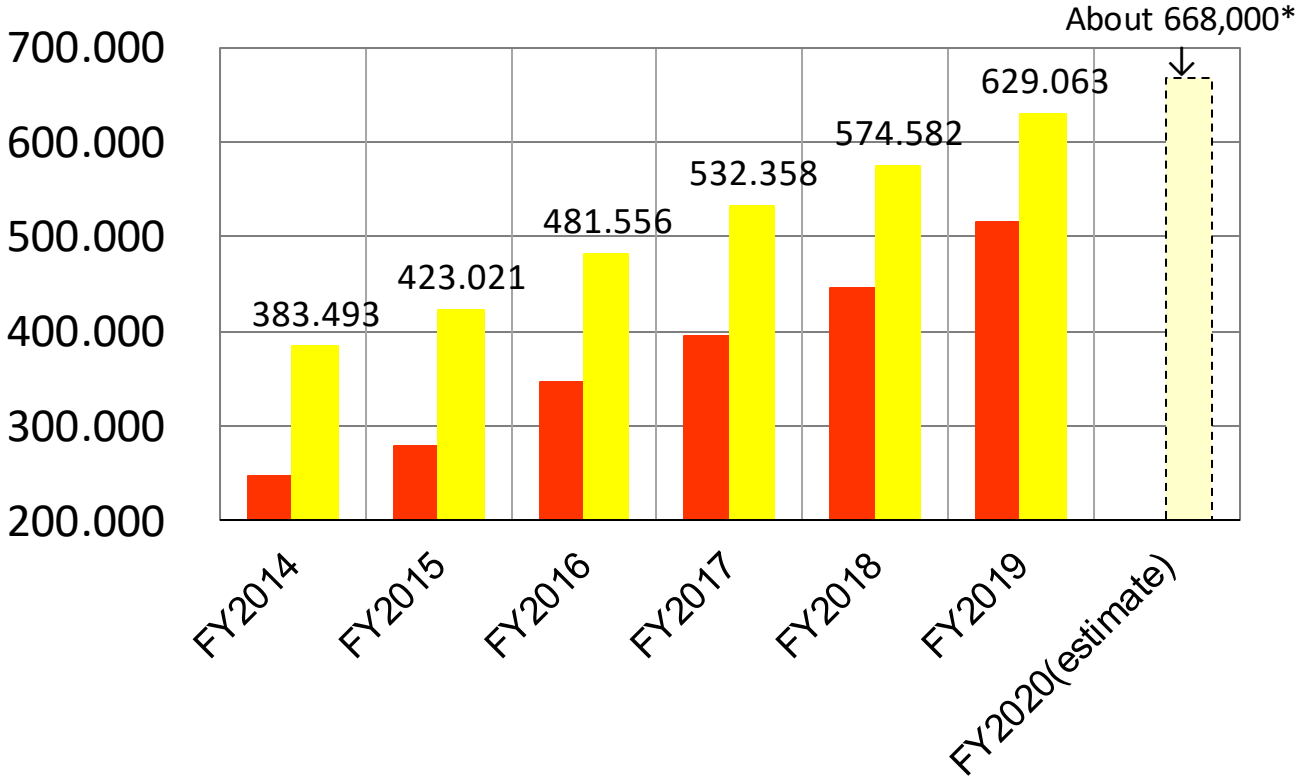
## Designation of special sediment disaster alert areas (Red)
(Areas with high risks for building damages and loss of lives or physical damages)

- Permission system for specified development activities
- Targets: Development activities for residential houses and land sales, social welfare facilities, etc
- Restrictions to building structures (areas other than urban planning areas are to be confirmed)
- Recommendation for transfer and so on to buildings with risks of serious damages in case of sediment disasters
- Securing finances and budgets to those who are recommended to move

Controlling increases of hazardous areas by development

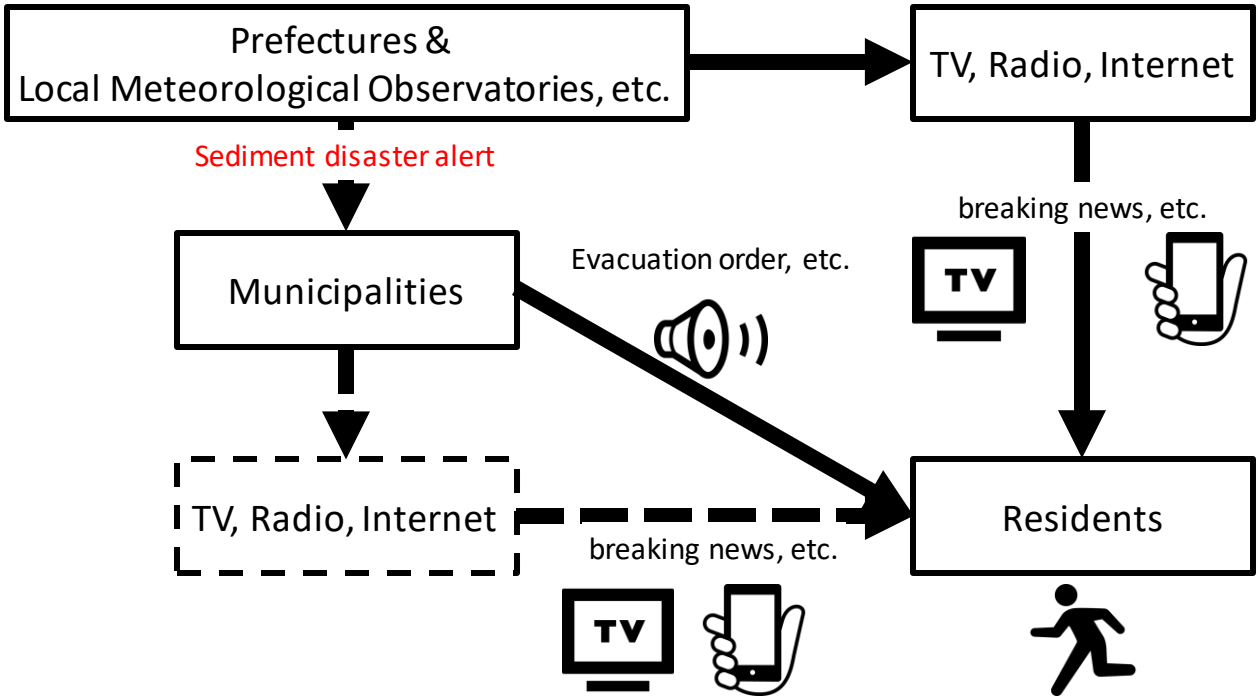


# Hazard Zoning (Basic Investigation)



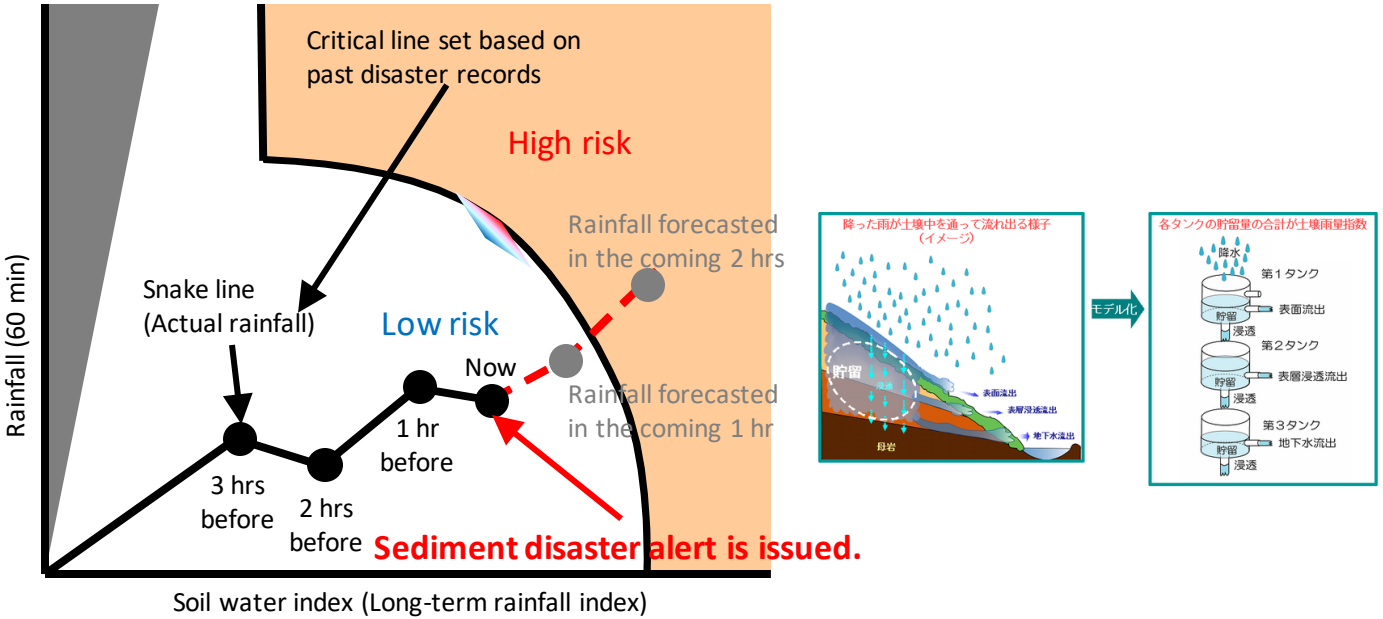

* Total number of Yellow Zones estimated to be conclusively designated by prefectures as of the end of FY 2019.

- Municipalities will issue evacuation orders, etc. based on the information.
- Residents evacuate based on evacuation orders, etc.
- The mass media mediates various information from the administration to the inhabitants.



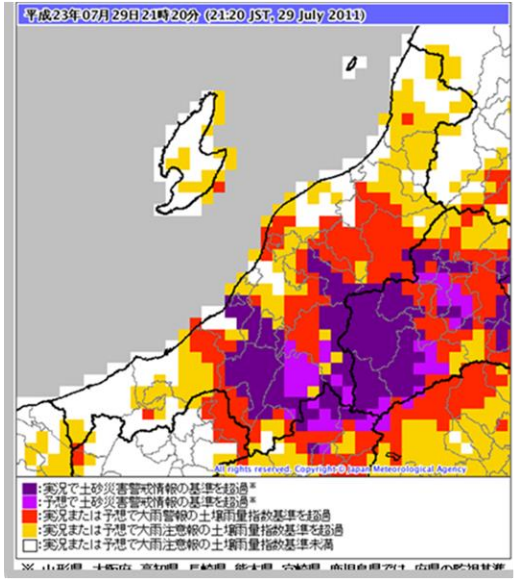
# About Sediment disaster alert

Purpose: To assist mayors in determining whether to issue evacuation recommendations/orders, and to provide residents with useful information for evacuation, during times of elevated danger due to rainfall.




**Concept of Sediment Disaster Alert**

- http://www.mlit.go.jp/river/sabo/seisaku/tebiki_r106.pdf
- http://www.mlit.go.jp/river/shishin_guideline/sabo/dsk_tebiki_h1706.pdf

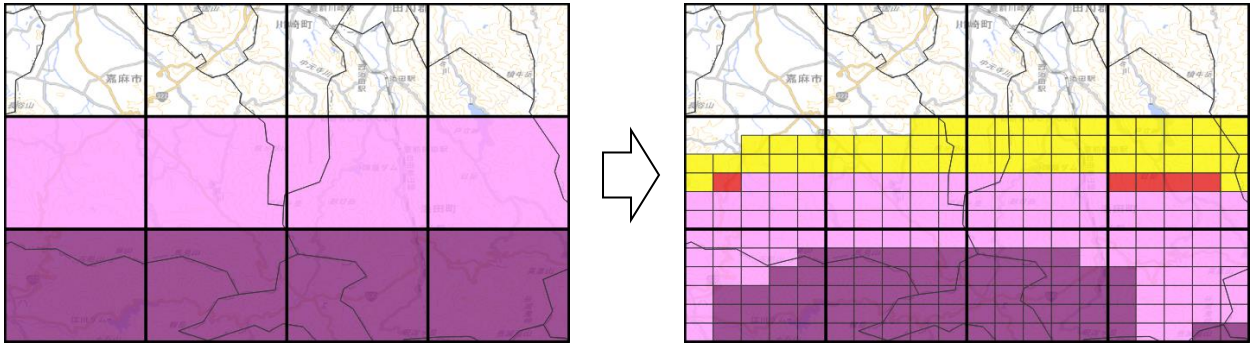



**distribution of risk**


**Color Legend**

To enable municipalities to make more effective use of the information provided by the Japan Meteorological Agency (JMA) through the judgment of evacuation advisories, the resolution of the landslide disaster warning judgment mesh information provided by the JMA has been increased from the 5km mesh to a 1km mesh.

**Before** **After**



Landslide Risk Map

# Debris flow countermeasures in Japan

# Manuals for debris flow and driftwood

ISSN 1346-7328
国総研資料 第904号
平成 28 年 4 月

国土技術政策総合研究所資料

TECHNICAL NOTE of
National Institute for Land and Infrastructure Management

No.904 April 2016

砂防基本計画策定指針（土石流・流木対策編）解説

土砂災害研究部 砂防研究室

Manual of Technical Standard for establishing Sabo master plan
for debris flow and driftwood

Sabo Planning Division
Sabo Department

国土交通省 国土技術政策総合研究所

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**Manual of Technical Standard for establishing Sabo master plan for debris flow and driftwood**

ISSN 1346-7328
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平成 28 年 4 月

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**Manual of Technical Standard for design Sabo facilities against debris flow and driftwood**

- http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0904pdf/ks0904.pdf
- http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0905pdf/ks0905.pdf

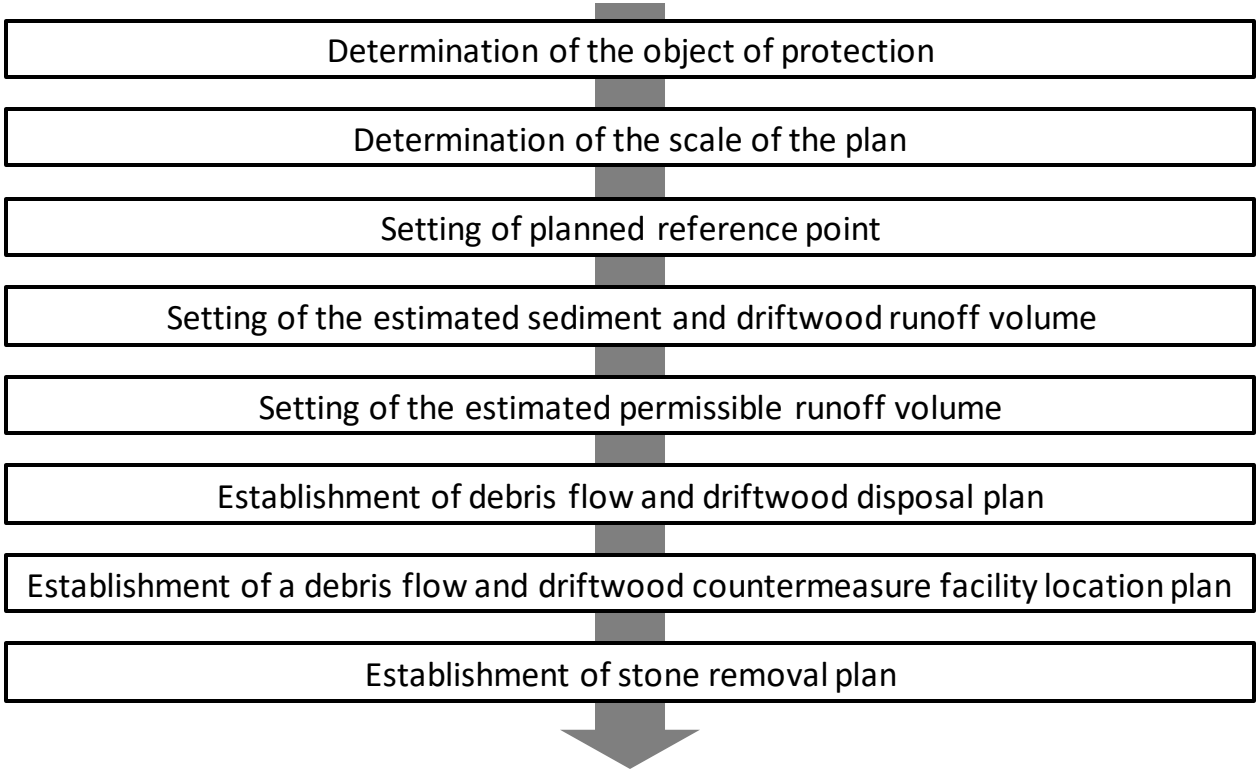
# A flow from investigation to construction of sabo facilities

Related to Technical Standards for establishing the Sabo master plan for debris flow and drift wood

Related to Technical Standards for designing Sabo facilities against debris flow and driftwood

- Sabo research (Desk and on-the-spot researches)
- Sabo master plan (Estimated sediment and driftwood runoff volume)
- Sabo master plan (Facility location planning)
- Preliminary designing of sabo facility (Comparison of facility structure and location)
- Detailed designing of sabo facility (Details of structure, design drawing, quantifying)
- Site research and surveying Site acquisition and application for designation as sabo site
- Implementation of countermeasure construction

The flow of establishing a facility location plan

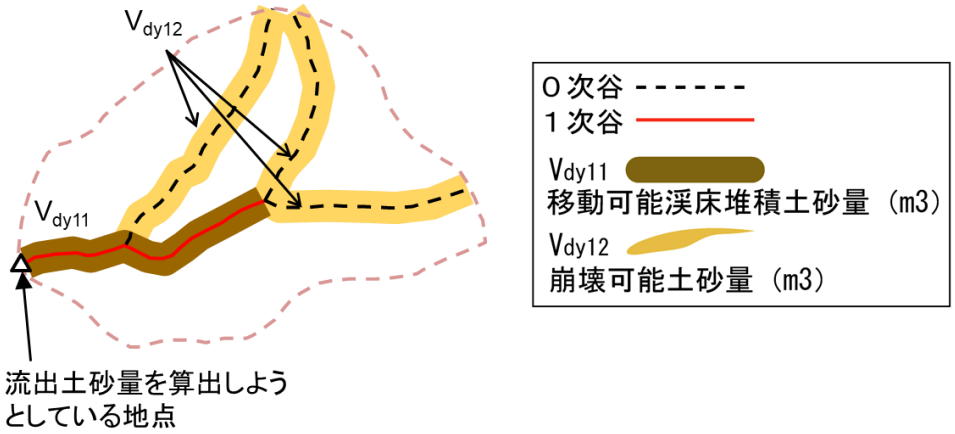


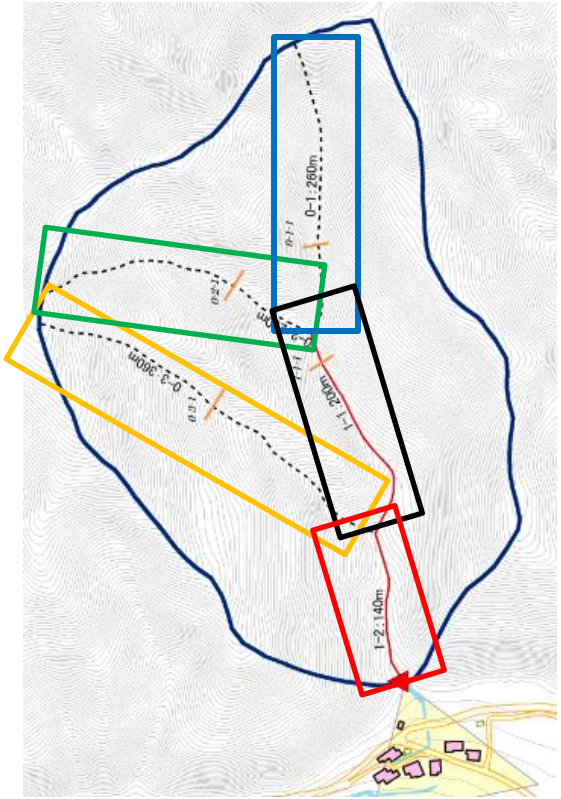
**Movable sediment volume**
- The amount of sediment that may possibly flow out downstream into the basin by debris flows and collapse

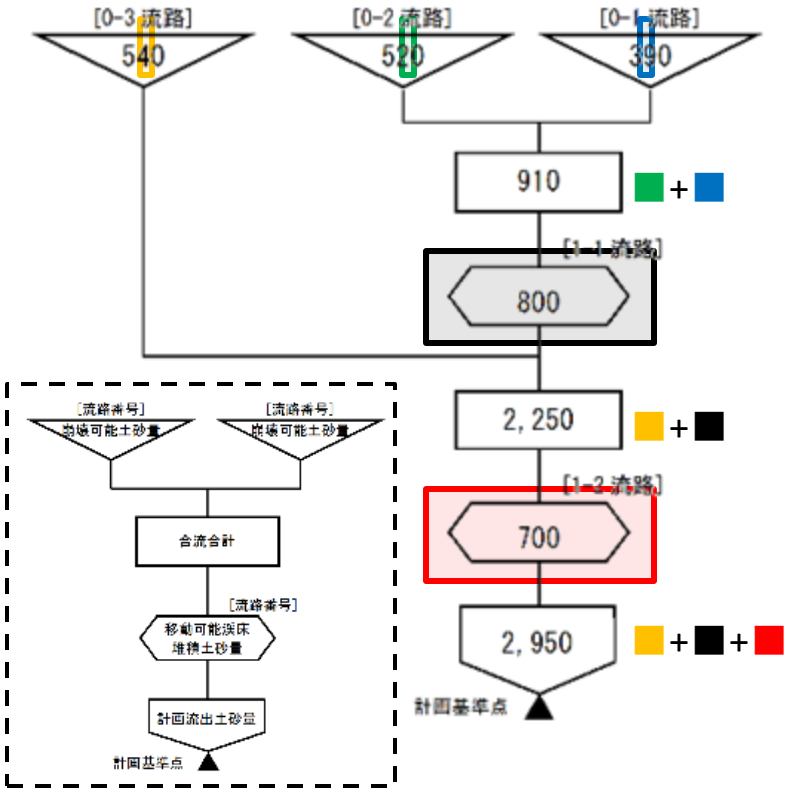
Compare

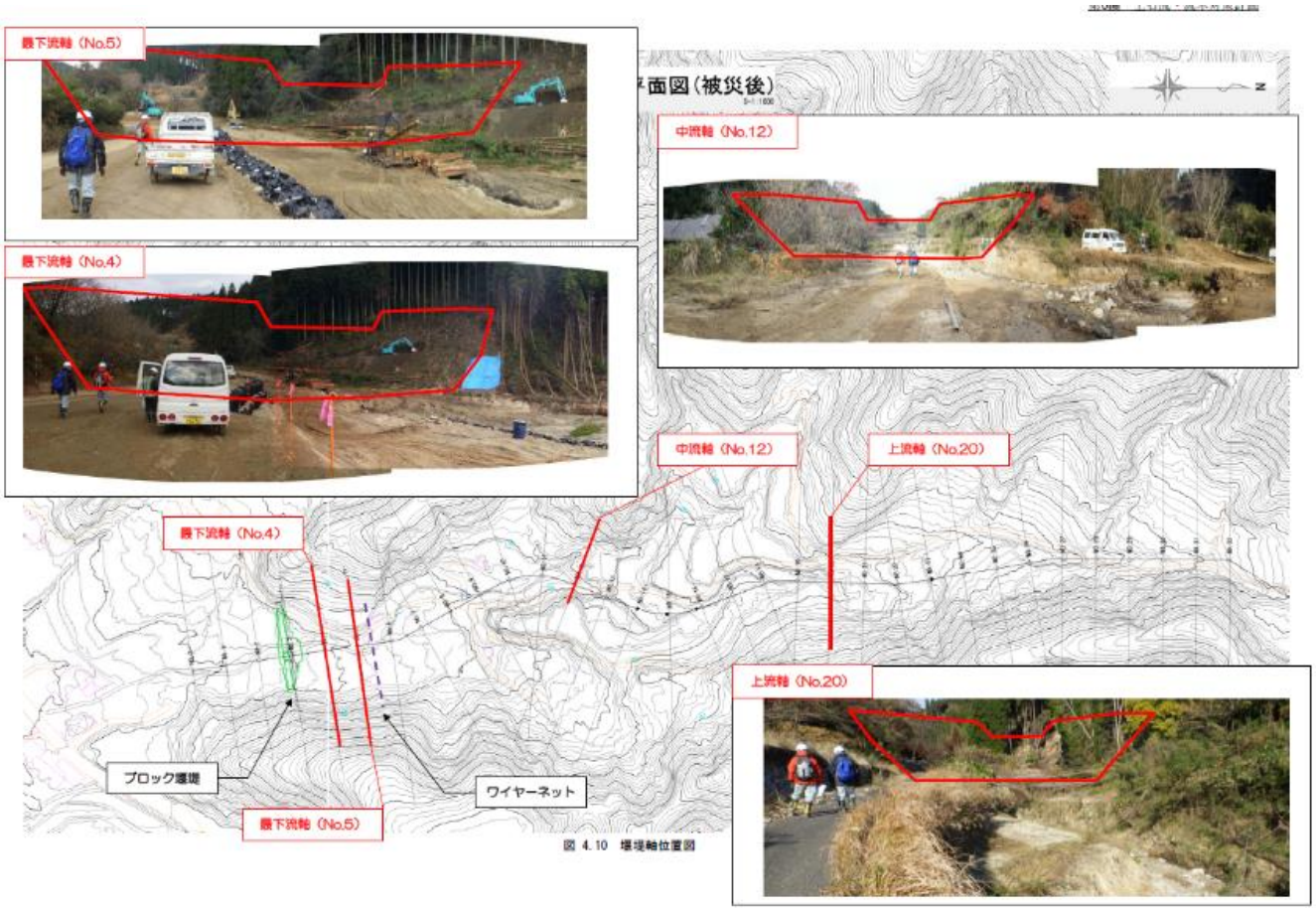
**Transportable sediment volume**
- Transportable sediment volume is calculated from the estimated-scale rainfall as well as the basin area and stream bed gradient at the planned reference point

Regard the smaller one as the estimated sediment runoff volume




0-1 260m
0-2 390m
1-1 200m
1-2 140m


[0-3 流路]
540
[0-2 流路]
520
[0-1 流路]
390
910
[1-1 流路]
800
2, 250
[1-2 流路]
700
2, 950
計画基準点
[流路番号]
崩壊可能土砂量
[流路番号]
崩壊可能土砂量
合流合計
[流路番号]
移動可能渓床
堆積土砂量
計画流出土砂量
計画基準点


最下流軸（No.5）
最下流軸（No.4）
面図（被災後）
中流軸（No.12）
中流軸（No.12）
上流軸（No.20）
最下流軸（No.4）
上流軸（No.20）
ブロック護岸
ワイヤーネット
最下流軸（No.5）
図 4.10 堰堤軸位置図

- Select an appropriate type of erosion control dam at the site.
- It is necessary to understand the characteristics of each kind well.

Open type sabo dam

Partially-Open type sabo dam

sabo dam

The lattice is blocked by the boulder that is concentrated on the head of the debris flow, and the debris flow is caught.


- **Video from the left bank**

https://jsece.or.jp/engineering/suirimokei/

# Notes for selecting type of sabo dam

Because the lattice spacing is large relative to the particle size of the debris flow, the blockage structure collapses and it is impossible to keep the trapped state of sediment, and sediment flow downstream.


- **Video from the left bank**

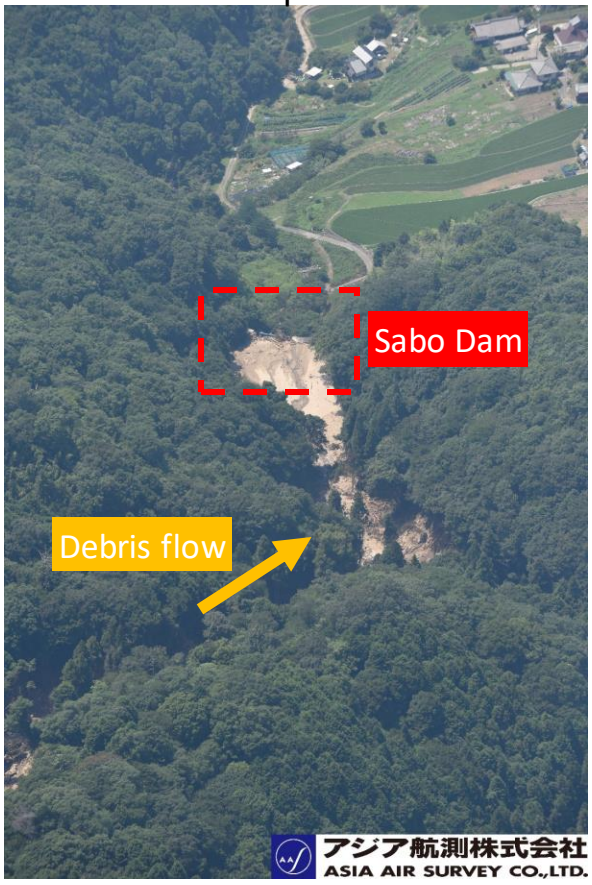
# Notes for selecting type of sabo dam

- Some driftwood will be caught, but some float in the water and flow downstream.
- Sediment will be caught until the sabo dam is filled. In addition, even after filling up the sediment, the sediment will be trapped on the upper surface of the sediment while flowing down to the downstream.


- **Video from the left bank**

# Effect of Sabo dam

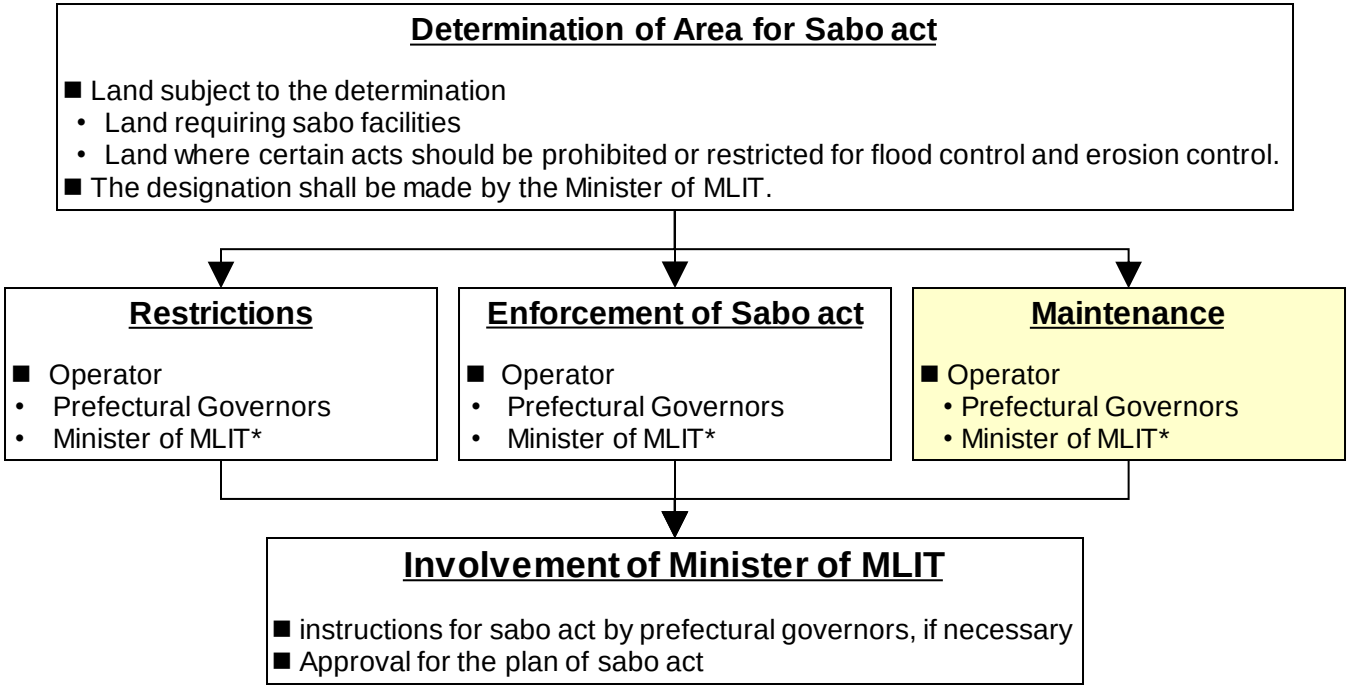
Sabo dams caught the debris flow and driftwood, so assets such as houses downstream were protected.




**Sabo dam caught debris flow and driftwood**

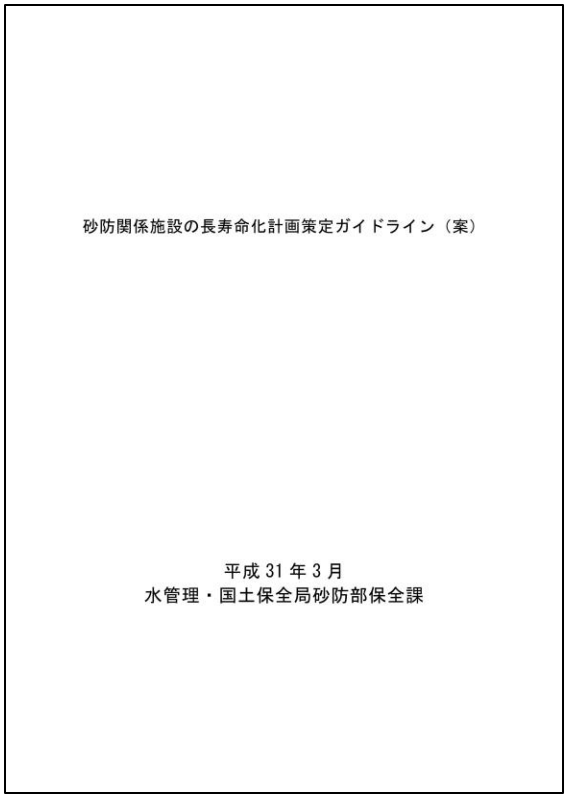
# Maintenance of Sabo Facility

- As with the implementation of sabo act, the maintenance of facilities is a duty of prefectures.
- The budgets for maintenance and management are to be prepared by prefectural governments with some exceptions.




*Cases in which interests are not limited to one prefecture , etc.

# Technical standard for maintenance of Sabo facilities


砂防関係施設の長寿命化計画策定ガイドライン（案）

平成 31 年 3 月
水管理・国土保全局砂防部保全課

**Guideline of establishing to extend the life of Sabo facilities (Provisional translation)**


砂 防 関 係 施 設 点 検 要 領（案）

平成 31 年 3 月

国土交通省砂防部保全課

**Outline for maintenance of Sabo facilities (Provisional translation)**

- http://www.mlit.go.jp/river/shishin_guideline/sabo/tyoujyu.pdf
- http://www.mlit.go.jp/river/shishin_guideline/sabo/tenken.pdf

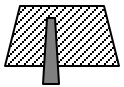
After the Sabo dam cough the debris flow, sediment that was caught by Sabo dam need to remove for the next debris flow.

**Before** **After**

Sabo dams that have deteriorated in function need to repaire.
In some case, Sabo dams that have been built according to old manuals are reconstructed.

**Before**

**After**



image

It is necessary to mow the grass which becomes an obstacle in the channel in the downstream of Sabo dam.

**Before** **After**

# Patrol and Inspection

A patrol and inspection is carried out to check for damage to Sabo dams, etc.

# Improvement Mechanism

Thank you for

your attention!!

# *Maintenance and Inspection of River Facilities and Dam and Upgrade of Existing Dam*

***Takashi SUZUKI, Deputy Director,***
***Water and Disaster Management Bureau,***
***Ministry of Land, Infrastructure, Transport and Tourism (MLIT)***

*October 10th, 2019*

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*October 10th, 2019*

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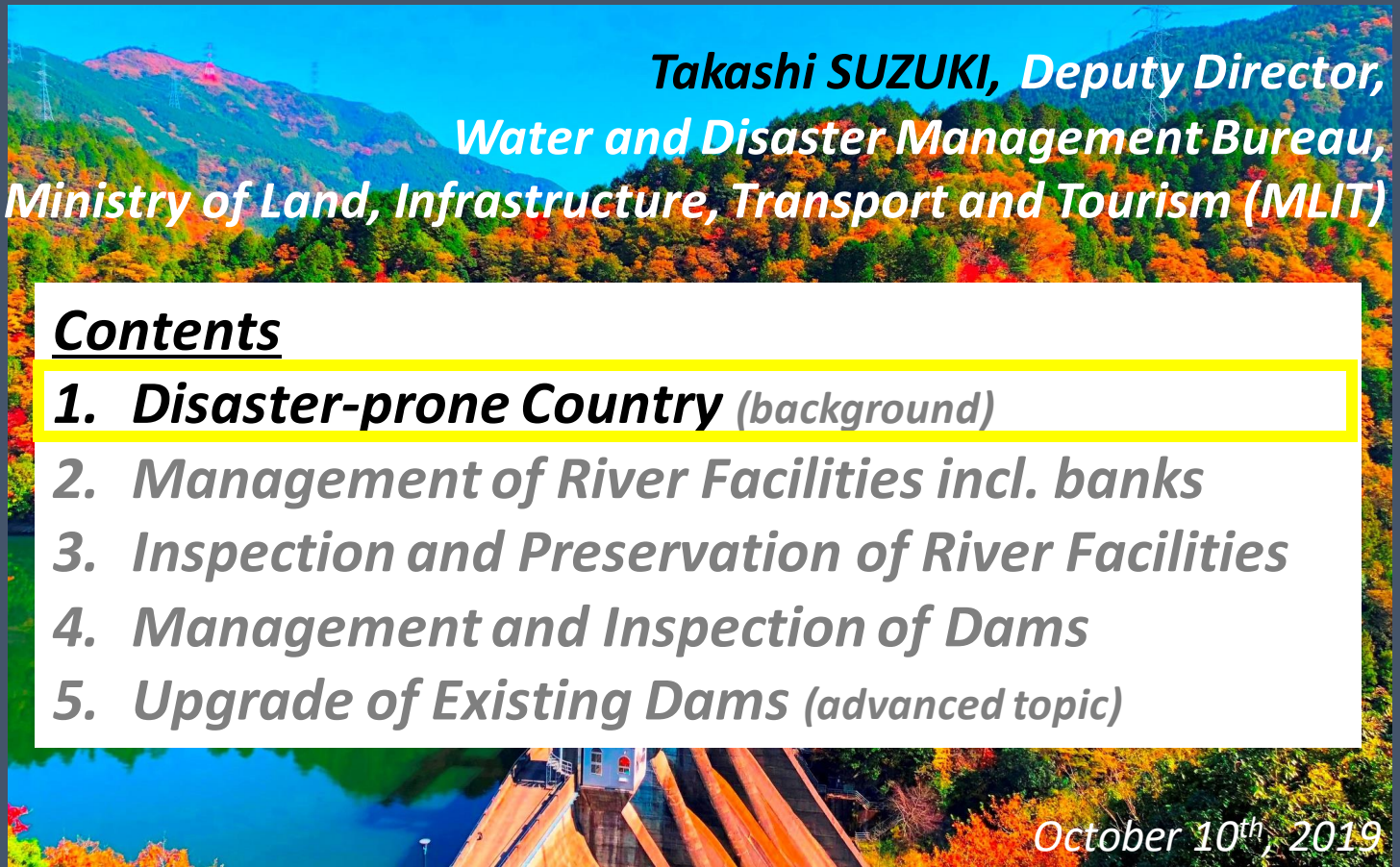

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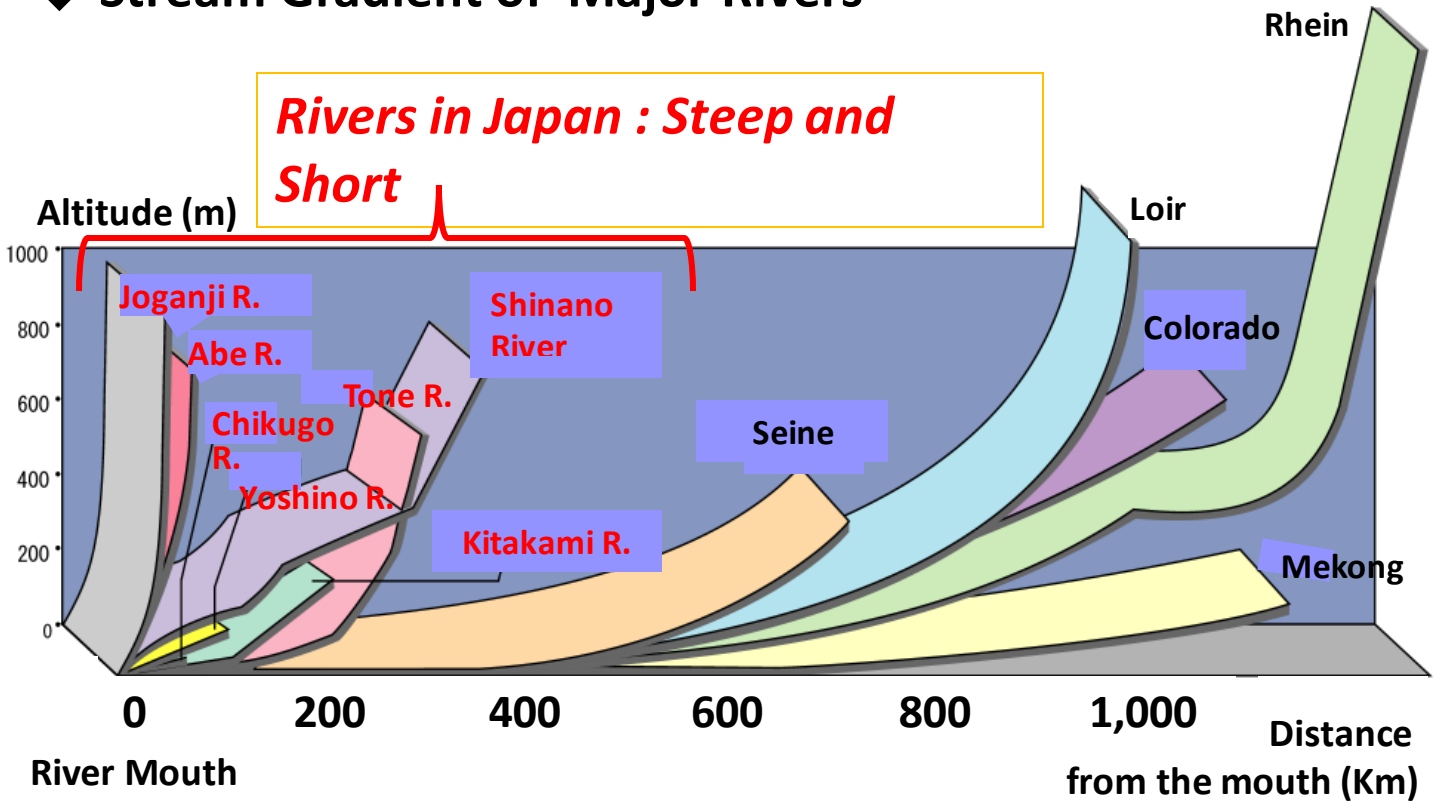
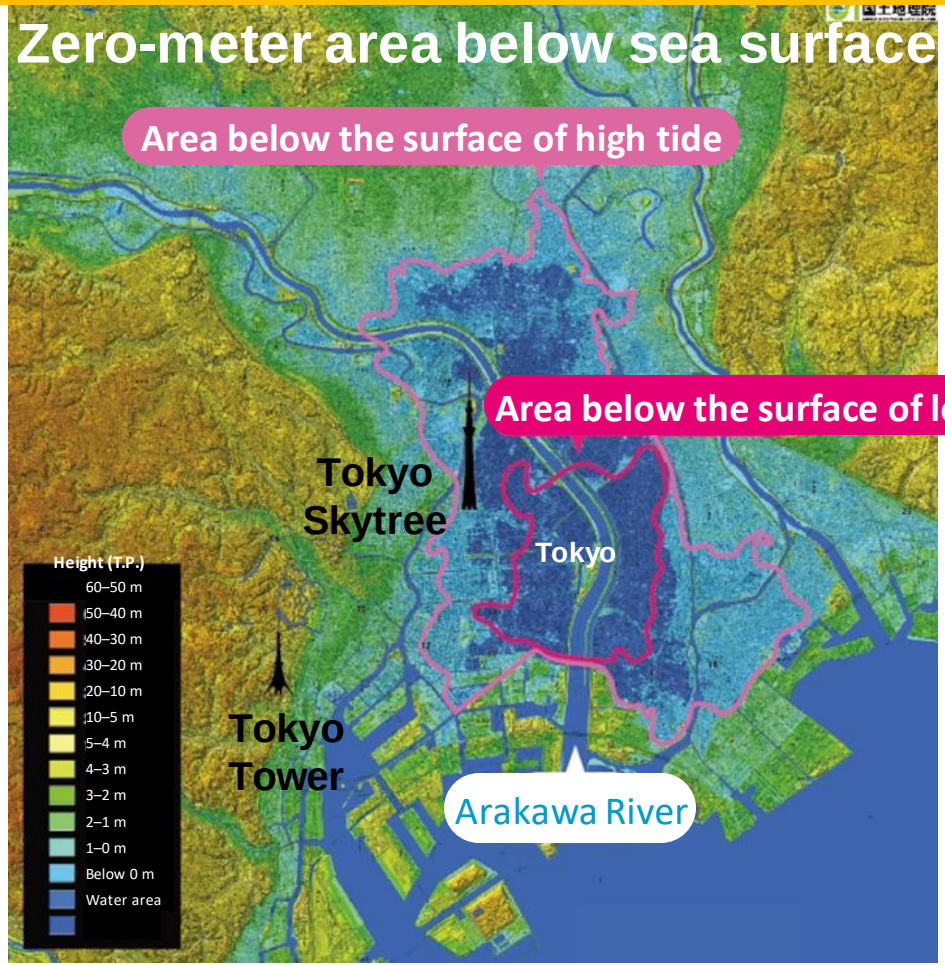
*October 10th, 2019*

# Disaster-prone Country

## ◆ Stream Gradient of Major Rivers



# *Disaster-prone Country*

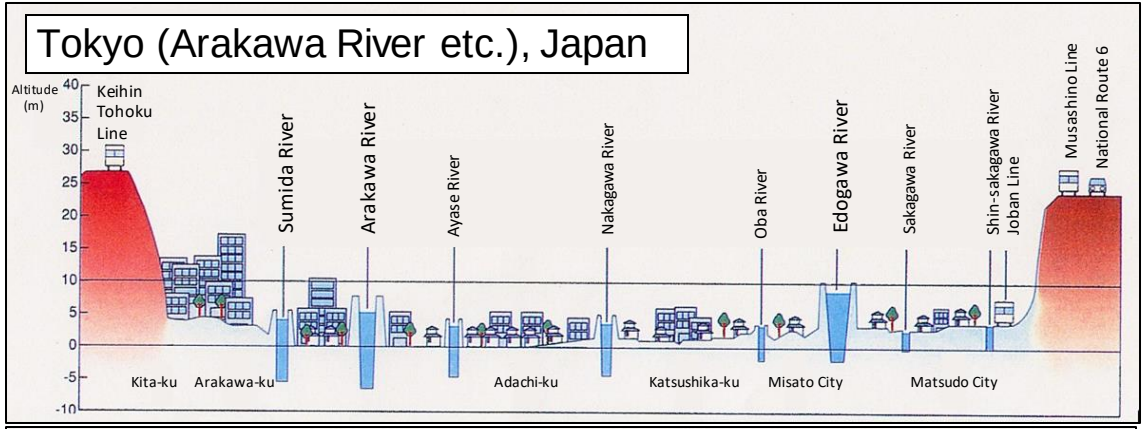


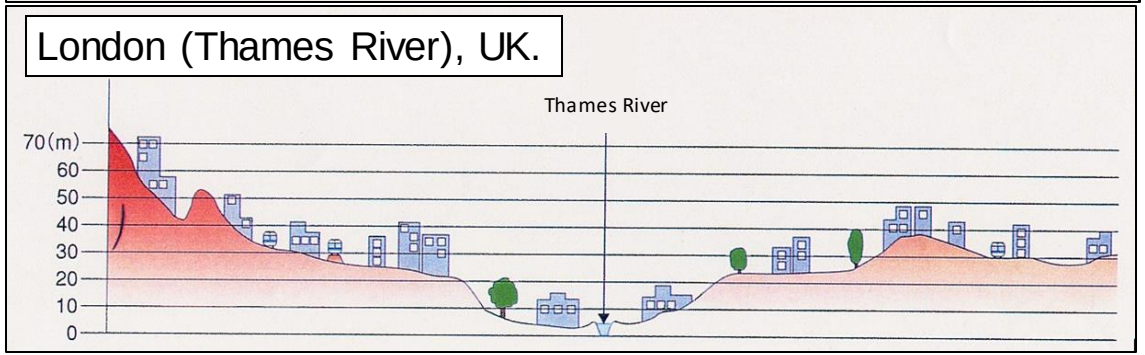

***Eastern Tokyo is low.***

# Disaster-prone Country

***Most of the urban areas in Japan are below the flood river water levels.***

◆ **Crosssection of the Cities**

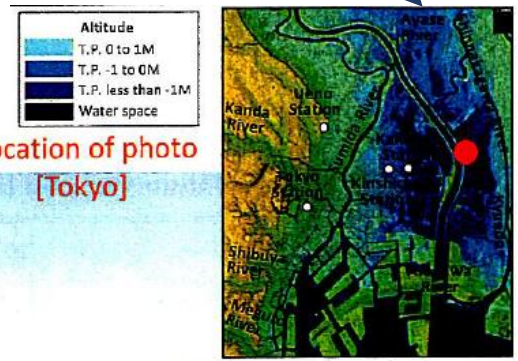


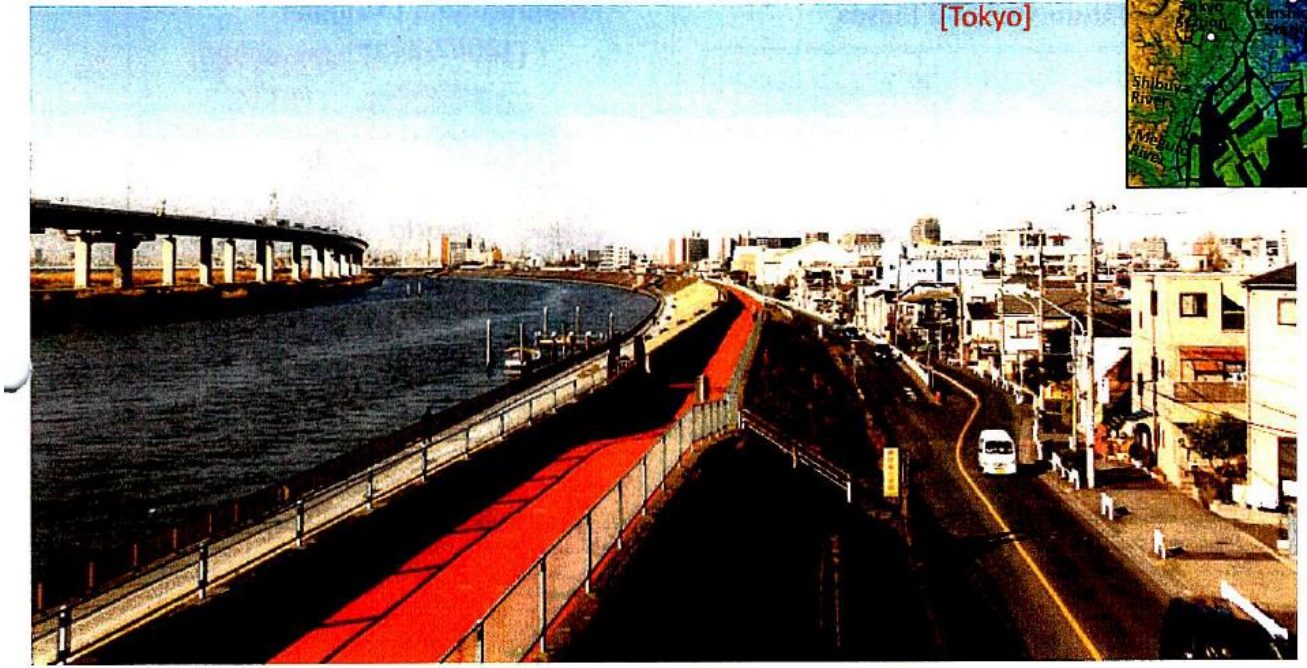
# Disaster-prone Country

***Most of the urban areas in Japan are below the flood river water levels.***

Lower than zero (0) meter




Location of photo [Tokyo]



# Disaster-prone Country

## *Tone River, near Tokyo, 1947*


**One of the largest rivers in Japan, flooding due to** Kathleen Typhoon 1947 **(just 2 years after the World War II).**

*Eastern Tokyo were widely inundated…*

# Maintenance and Inspection of River Facilities and Dam and Upgrade of Existing Dam

**Takashi SUZUKI, Deputy Director,**
**Water and Disaster Management Bureau,**
**Ministry of Land, Infrastructure, Transport and Tourism (MLIT)**

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October 10th, 2019

# River Bank (Embankment) is important !

**Kanto-Tohoku torrential rain (2015)**

bank collapsing

Wide areas are affected when the bank collapse.

**Tokai torrential rain (2000)**
**Near Nagoya-City**

# River management facilities (river structures)

- Various river management facilities are installed in rivers, including dams, sluice gates/sluice pipes and pumping stations, as well as river embankment.

Weir

Sluice gate

Sluice pipes

Drainage pumping station

Ground sills

Lock gate

# Management of river course

- Rivers, which are public property, each have unique characteristics and there are even different sections in each river.
- River conditions change both in the short term and in the long term due to flooding, daily water flow and changes in vegetation, etc.
- Those changes are not necessarily uniform, and there are occasionally sudden changes.
  ➔ Conditions should be observed regularly.

## Deposits of earth and sand

## Corrosion of riverbed and riverside

## Growth of trees and shrubs in river channels

# *Issues of river course/ bank management*

- Forms of river channels and banks are constantly changing due to the effects of water flow, etc.
- Banks are linear structures with extremely long extension, and flood control functions of a whole section will be lost if even one point has been broken.
- As even a small hole will cause a dike break, the local safety of a series of banks is regulated.
- Serious damage occurs when the banks of a large river break.

Sept. 2001 Typhoon no. 15
Flooding of Edo River


Dike break in Yabe river system
on July 14, 2012

# *Dyke breach by overtopping*

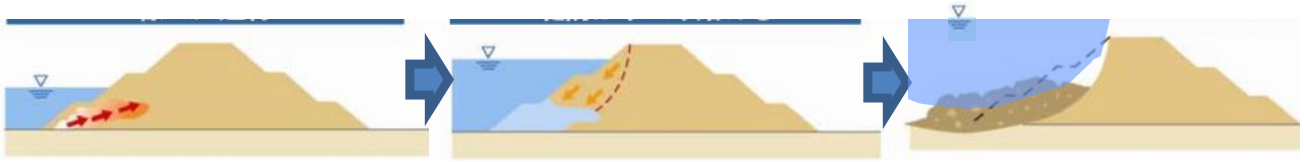
●Dyke breach due to overtopping (illustration)

River water overtops the bank causes erosion of the foot of the back slope, made the bank to collapse.

Example: Koyoshi River in Ishizawa river system　Bank collapse due to overtopping (flooding in June 2011)


# *Dyke breach by erosion*

- Dyke breach caused by erosion/scouring (illustration)
  Erosion caused by river water develops to the scouring of the foot of bank slope etc. and lead to the bank collapse.

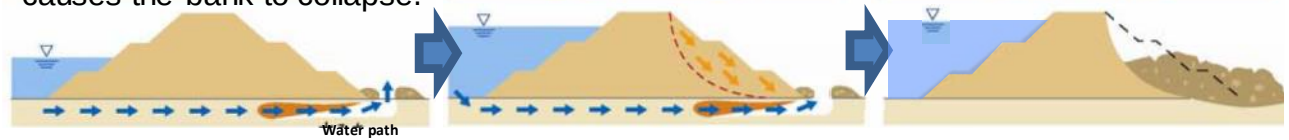


Example: Arakawa River in Abukuma river system　Bank collapse due to erosion
(Sept. 1998 Typhoon no. 5)

# Dyke breach by seepage

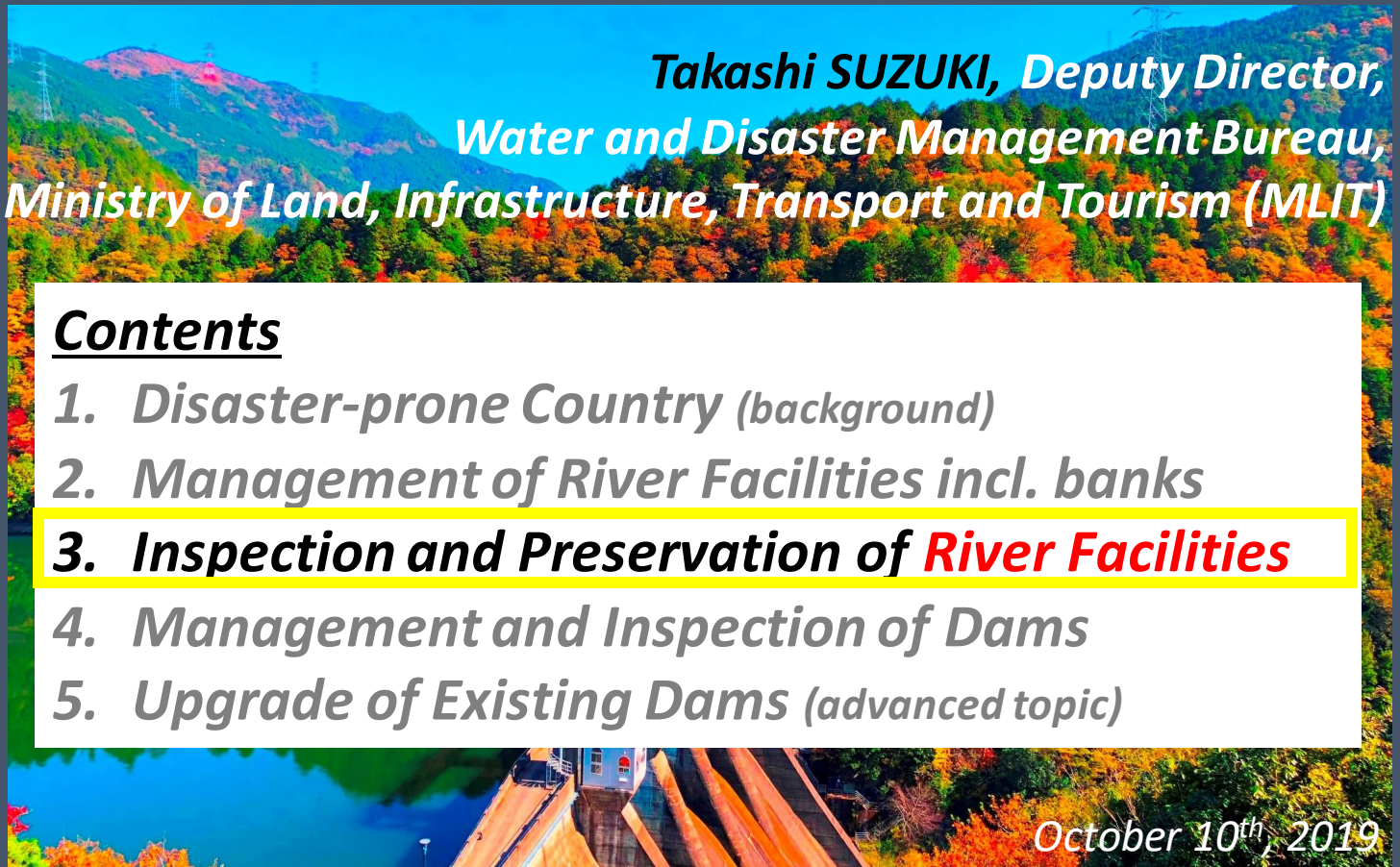
- Dyke breach by seepage (illustration)
  River water percolates the bank, causing the water level inside the bank to rise, which weakens the bank and causes it to collapse.

- Dyke breach by piping (illustration)
  A pipe-shaped water path is formed inside the ground, and when this water path widens it causes the bank to collapse.




Yabe River in the Yabe river system　Bank collapsed due to destruction of piping (July 2012)

# *Maintenance and Inspection of River Facilities and Dam and Upgrade of Existing Dam*



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*October 10th, 2019*

# *Various deformations that occur in banks*

Formation of rut

Growth of vegetation

Formation of cracks

Gully erosion due to rainfall

Formation of holes by animals

Slope slippage during rainfall

**Example of Tone River**

Raised by approx. 1m

Land subsidence

Usually most of these deformations **gradually expand and become major causes of dike breaks when floods occur**

➔ **Daily maintenance and management is important**

# River inspection in normal times

River inspection is carried out in normal times in order to ascertain the conditions of river management facilities, etc.



Sometimes PDAs are used to record conditions observed in inspections as electronic data.
Past records are also displayed immediately.

# *Inspection of river management facilities*

- River inspections, checks and observations are performed in order to maintain facility functions and restore the functions of damaged facilities.

River inspection (generally watching)


River management facility checks


Bank weeding


River geographical Survey


Bank check (cracks and collapse, etc.)


Hydraulic/hydrogeological observation

# *Preservation Measures for River Management Facilities*

- Based on condition monitoring results, carry out repairs, etc., in order to maintain the functionality of facilities and restore the functionality of damaged facilities.

Slope gully corrosion repairs

Bank crack repairs

Dike crack repairs

# Strategic Maintenance/Renewal

## Conventional maintenance "Scheduled maintenance"

・Equipment that has a fatal effect on the functionality of facilities if broken, and machinery for which condition monitoring is currently difficult to carry out.
・Fatal damage is protected against by means of regular replacement and renewal according to age

[Target Equipment]
Electronic control devices, and pump facility shafts, etc.


Control panel


Impeller (blade)


Gate roller

In the future, equipment that tends to deteriorate that is managed by condition will switchover to condition monitoring maintenance

Switchover to corrective maintenance for equipment that does not have a fatal effect on facilities when broken

## Condition monitoring maintenance

Ascertain the damage by means of an inspection, and prevent fatal damage by carrying out replacement/renewal at the optimal time

[Target Equipment]
Gates,opening devices, etc.


Gate


Opening device

## Corrective maintenance

Use until there is a decline in functionality, and derive maximum cost-effectiveness.

[Target Equipment] Operational support devices, duplexed equipment, etc.


Operational support device


Fuel transfer pump

# Strategic Maintenance/Renewal

- Implement countermeasures against deterioration by using highly-durable materials, etc., when renewing facilities in order to reduce the total cost of renewal

## Sluice pipes

Reduce future coating costs, etc., by replacing deteriorated steel sluice pipe gates with stainless steel gates.

Steel gates

Stainless steel gates

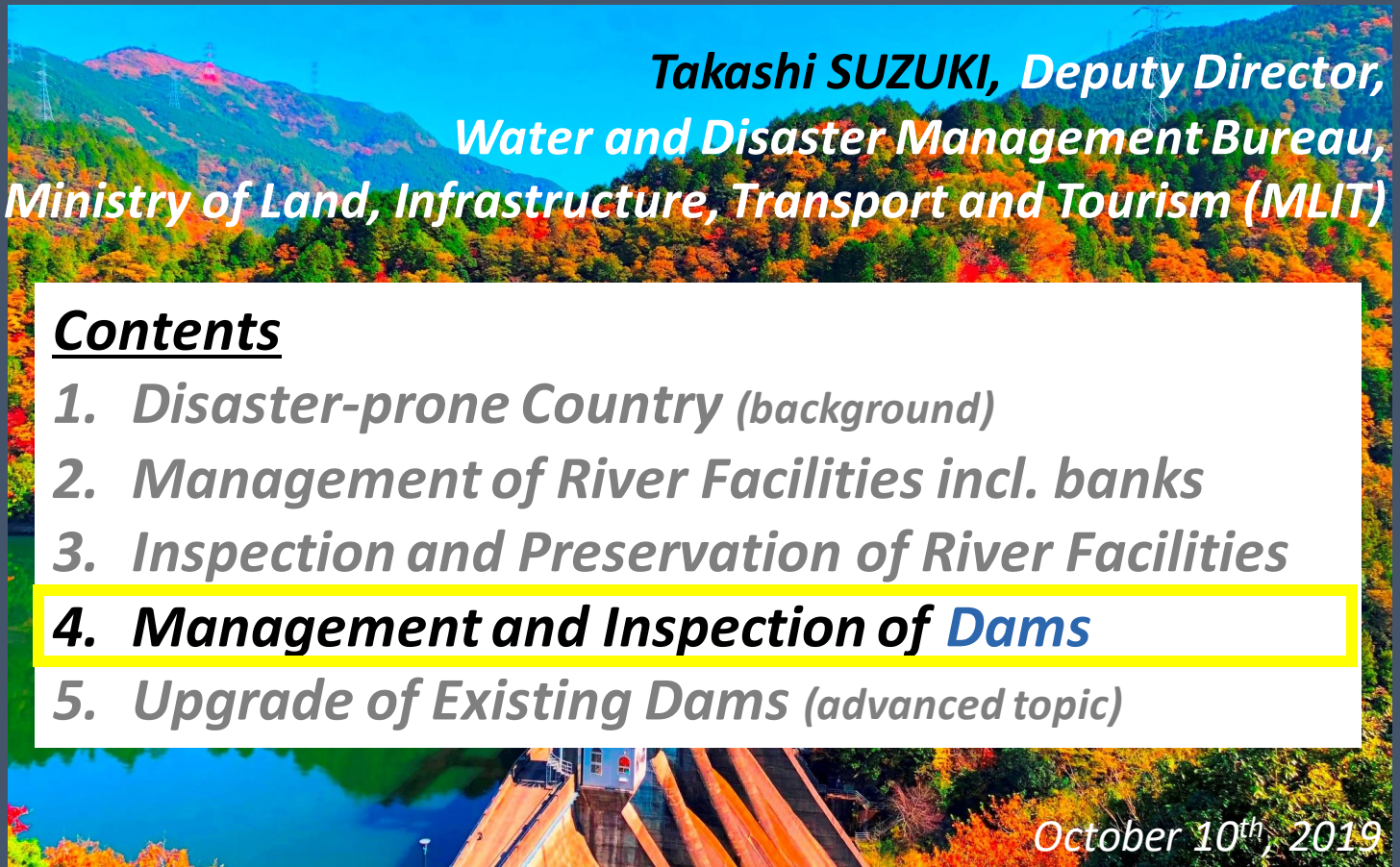
## Drainage pumping stations

Reduce future maintenance costs by replacing water-cooling on deteriorated pump shaft seals with air cooling.


Water-cooling

Air cooling

# *Maintenance and Inspection of River Facilities and Dam and Upgrade of Existing Dam*



***Takashi SUZUKI, Deputy Director,***
***Water and Disaster Management Bureau,***
***Ministry of Land, Infrastructure, Transport and Tourism (MLIT)***

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5. *Upgrade of Existing Dams (advanced topic)*

*October 10th, 2019*

# How Dams Work

## Katsura River, Kyoto (Yodo River System)

**Typhoon No. 18 in September, 2013**


**Inundated at Sightseeing Area (Traditional Townscape) in Kyoto**

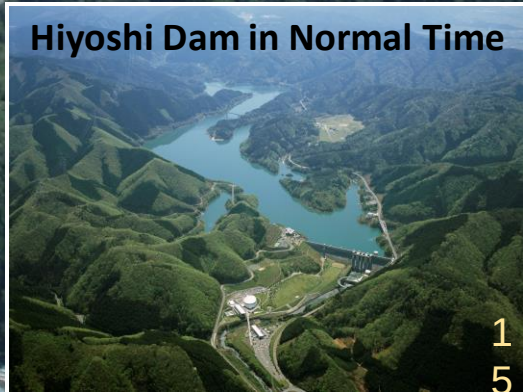
## *How Dams Work*

# Flood Control

45 million $m^3$ stored

**Hiyoshi Dam**

**dealing with the flooding**
**due to Typhoon No. 18 in September, 2013**



# How Dams Work

## Increasing of Water Demand




*To meet the demand of water use*
*Construction of Large Dams started*




Source; JWA ( Aichi Canal Project )

# How Dams Work

## Usage and Distribution of Water (agricultural, industry, drinking, etc.)

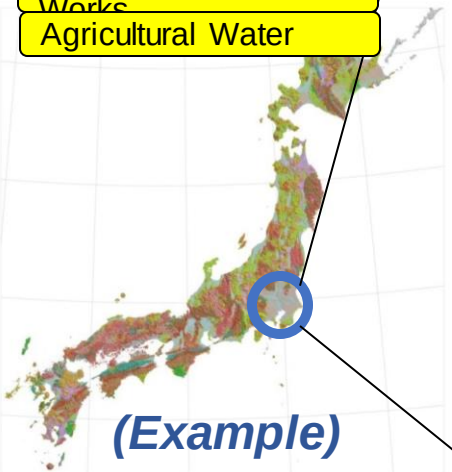
(Legend)

JWA's Project | Non-JWA's Project

Tap Water Works

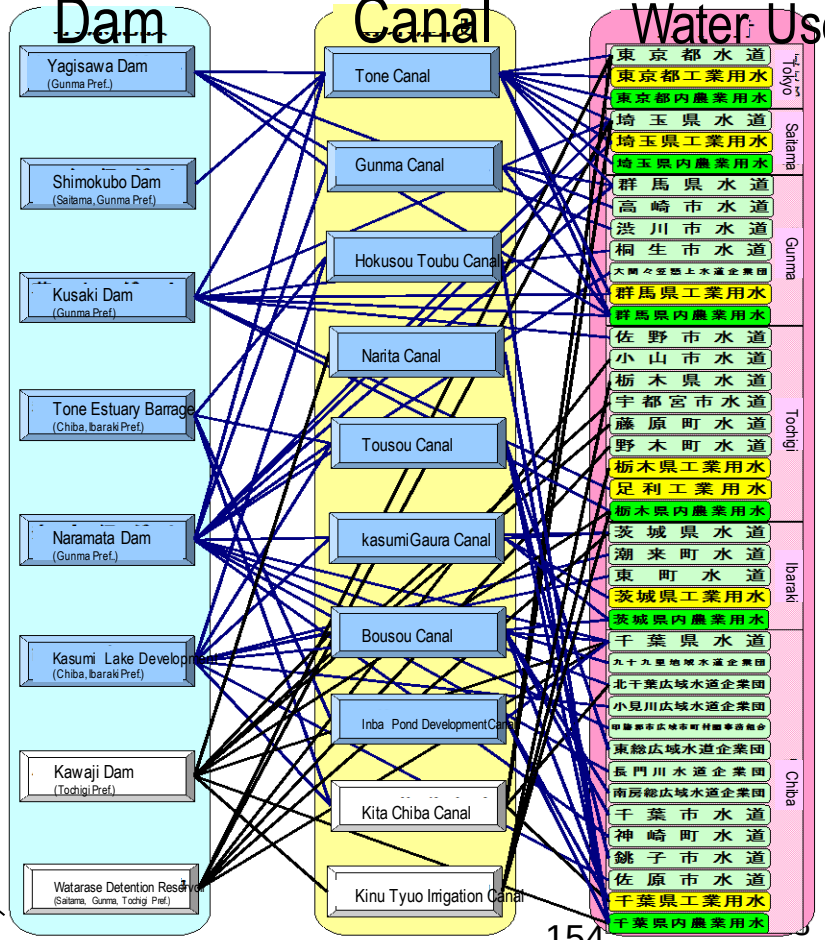
Industrial Water Works

Agricultural Water



(Example)

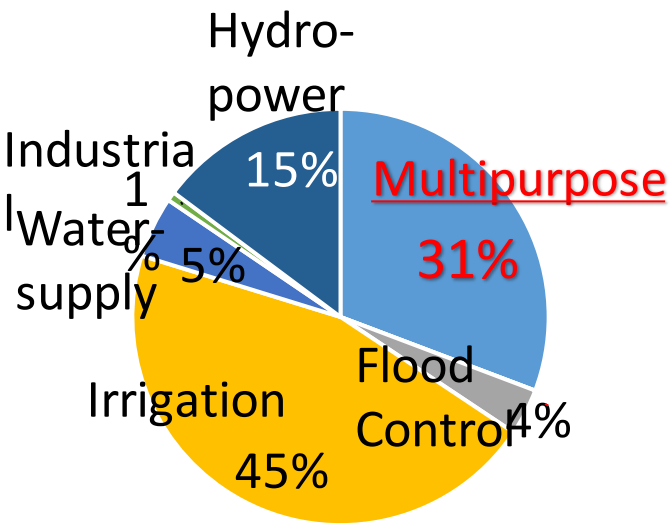
**Tone&Ara River Basin**



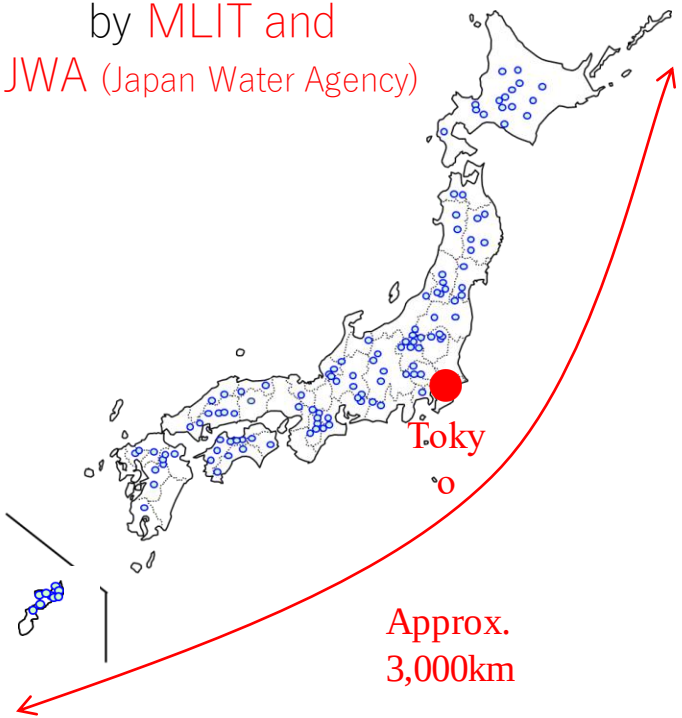
# Dams in Japan

✓ On Japan's land extending over 3,000 km with various climatic zones, 2,666 dams have been constructed.

## 2,666 dams by purpose

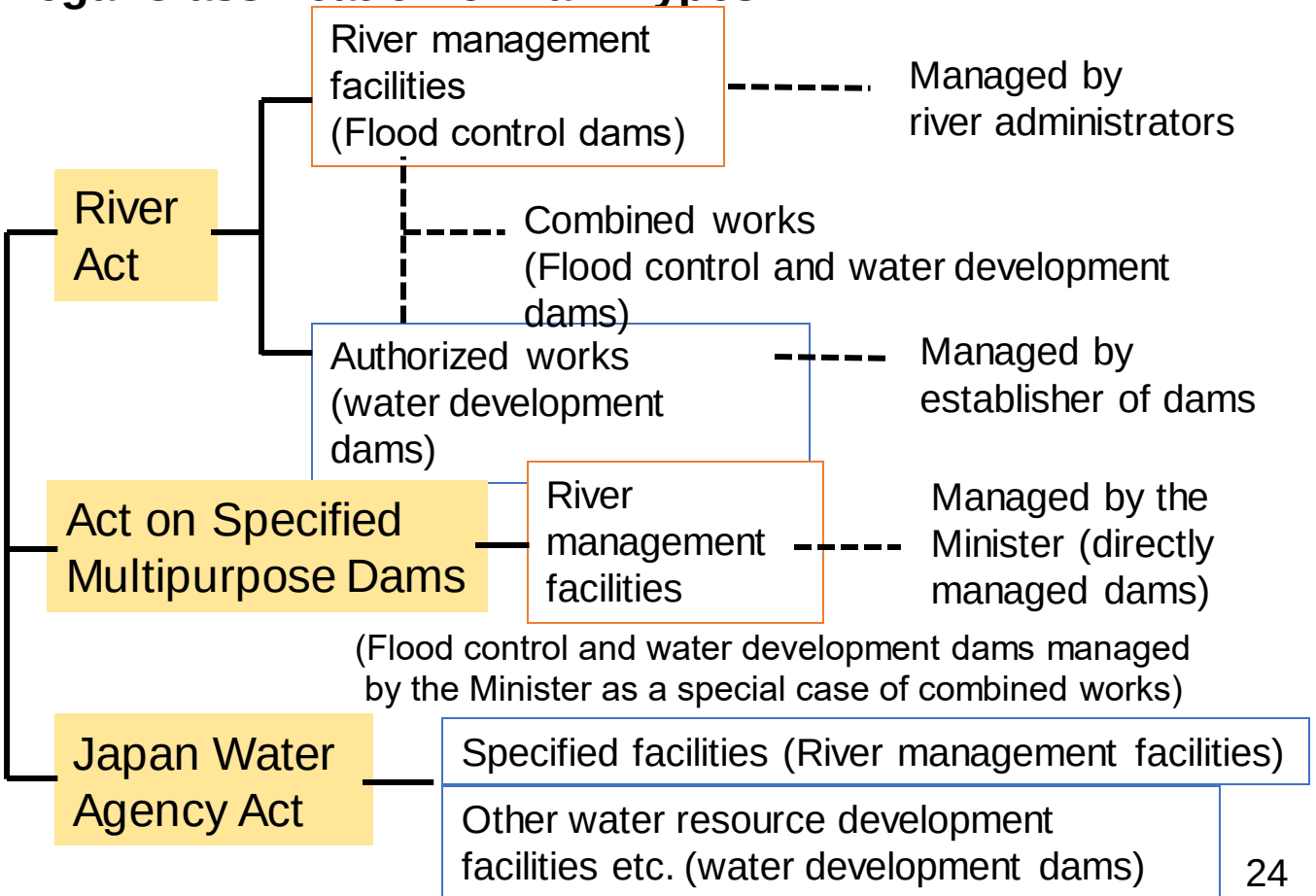



## 123 dams managed by MLIT and JWA (Japan Water Agency)



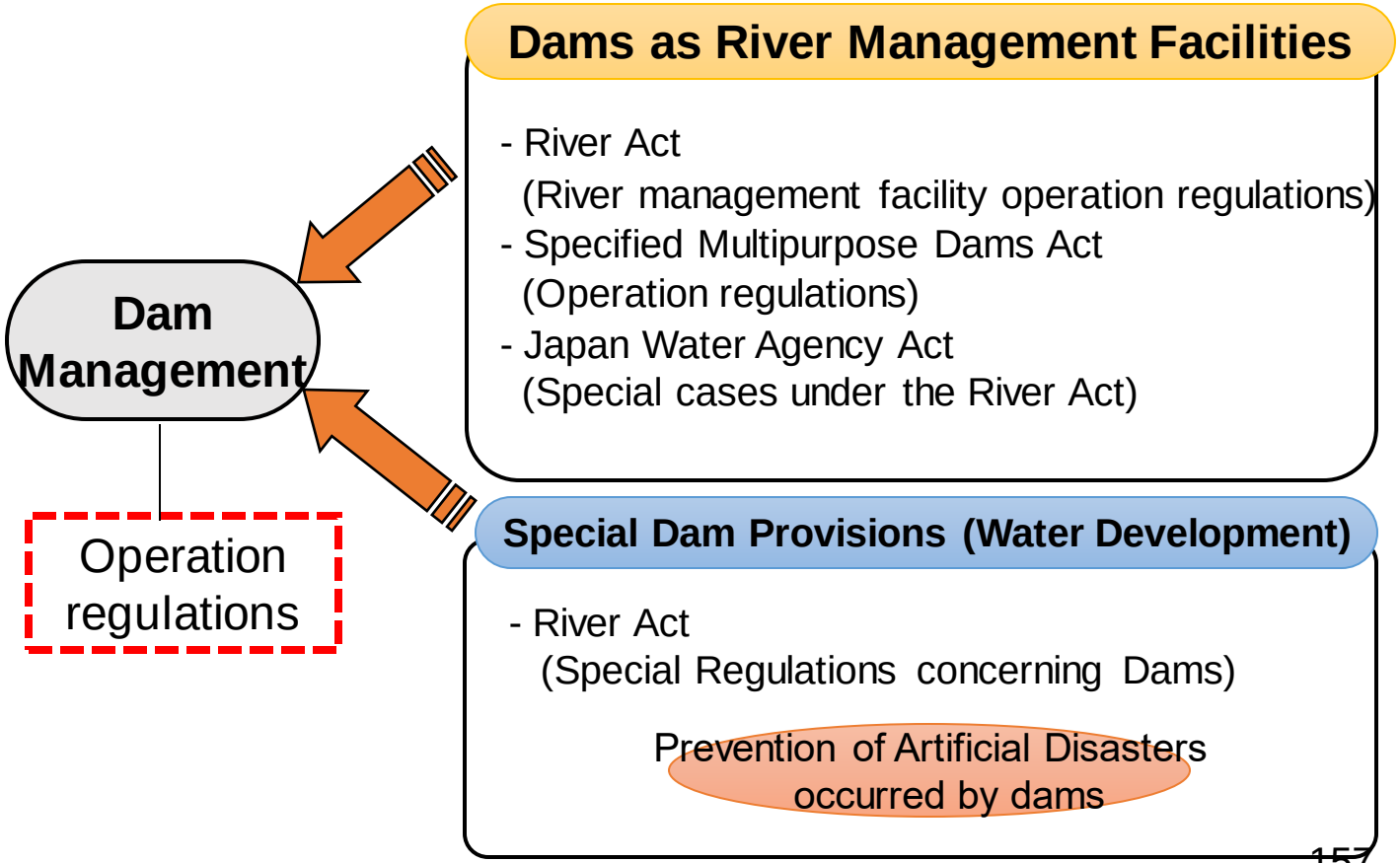
# Legal and Institutional Framework in Dam Inspection

## ◆ Legal Classification of Dam Types



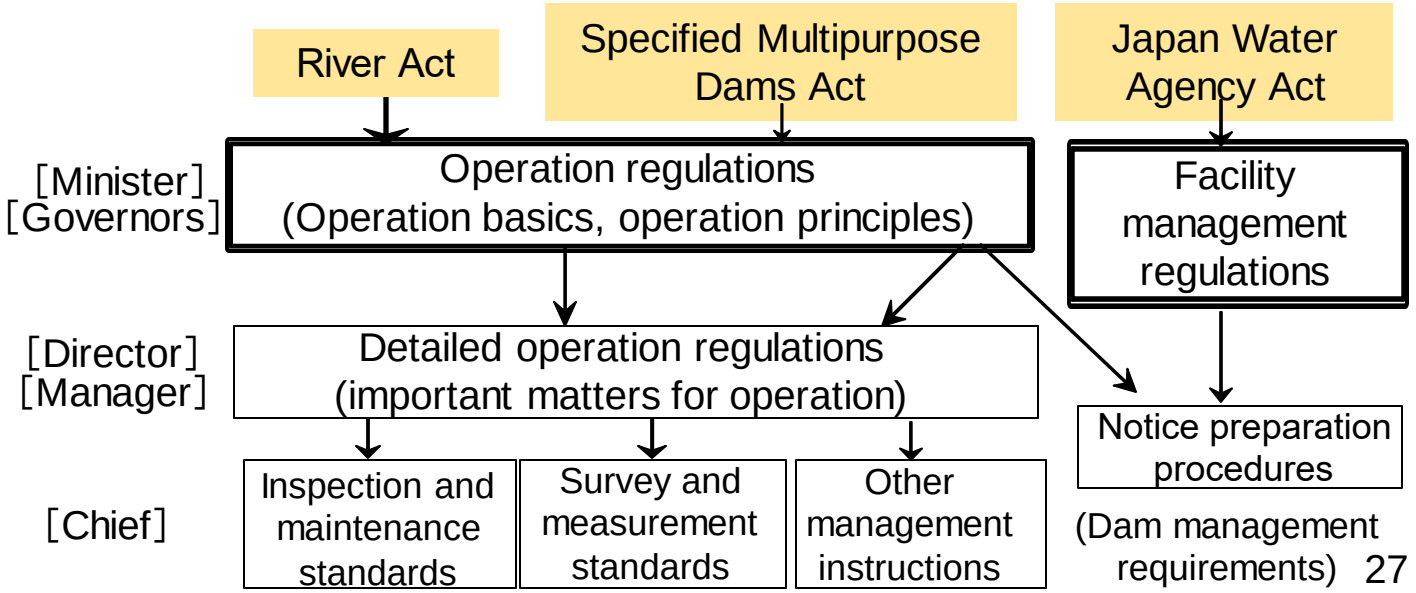
# *Legal and Institutional Framework in Dam Inspection*

◆ Dam Management and Roles (Legal Classifications)

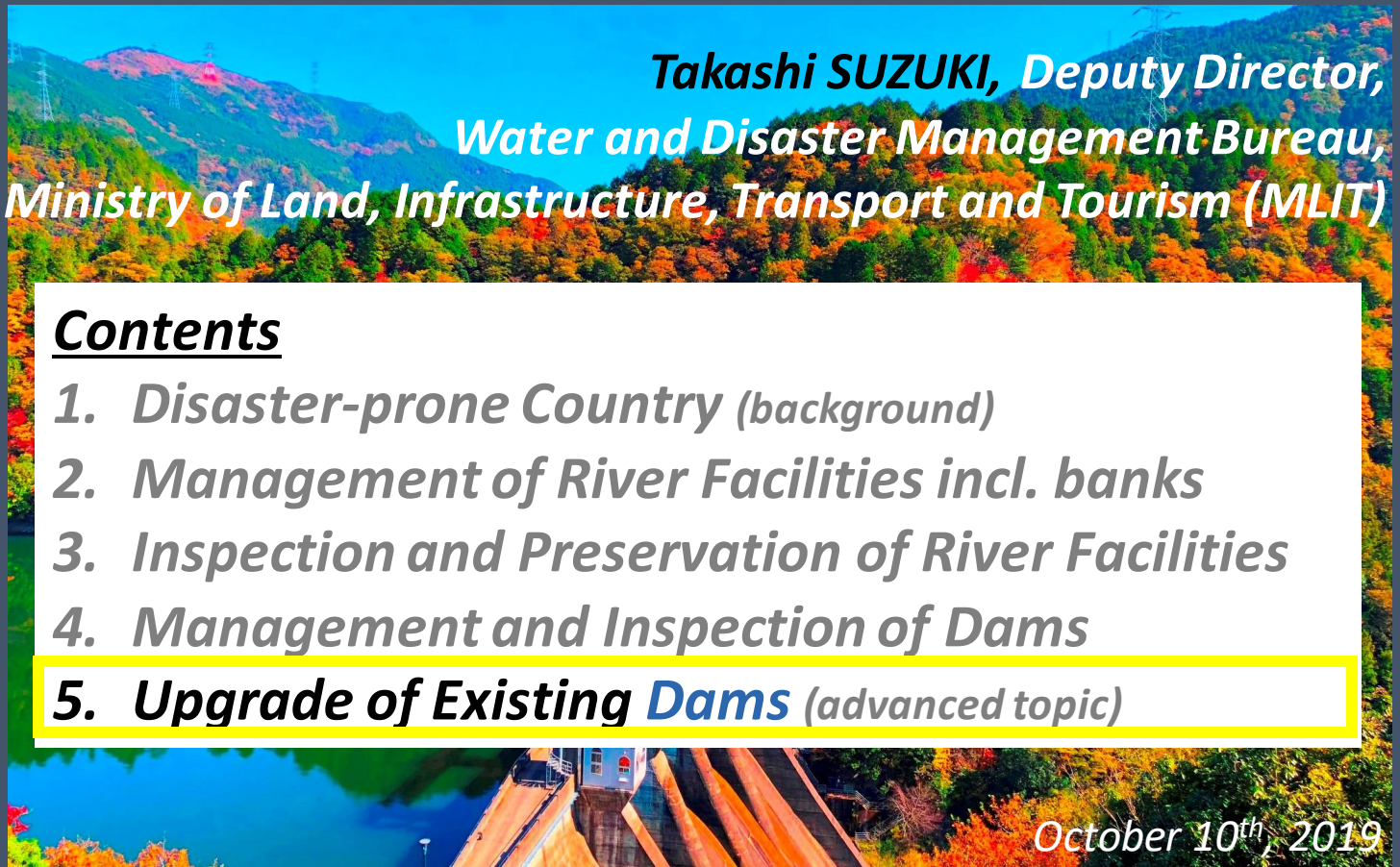


# Legal and Institutional Framework in Dam Inspection

- Methods of storage and discharge and high and low water levels as specified for flood periods and irrigation periods etc.
- Inspection and maintenance of equipment and instruments necessary for multipurpose dams and multipurpose dam operation.
- Necessary weather and water condition observations for the operation of multipurpose dams.
- Measures to be taken when discharging.
- Other necessary matters related to the operation of multipurpose dams.



# *Maintenance and Inspection of River Facilities and Dam and Upgrade of Existing Dam*



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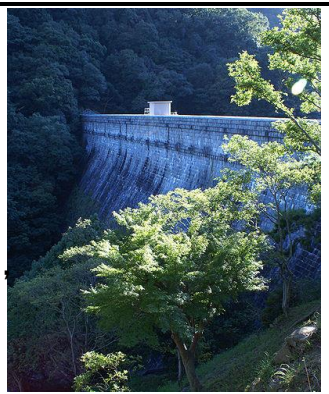
# *Japan's Dam Maintenance and Management*

✓ The Japan's first concrete dam, Nunobiki-Gohonmatsu Dam, has been supplying water to Kobe City over 100 years, relaying on appropriate maintenance based on technical standards.

## The 1st Gravity Dam

Nunobiki–Gohonmatsu Dam, 33.3m height, built in 1900



## Rockfill Dam

Kobuchi Dam
20.5m height, built in 1951

## High Dam

Maruyama Dam
98.2m height,
built in 1955

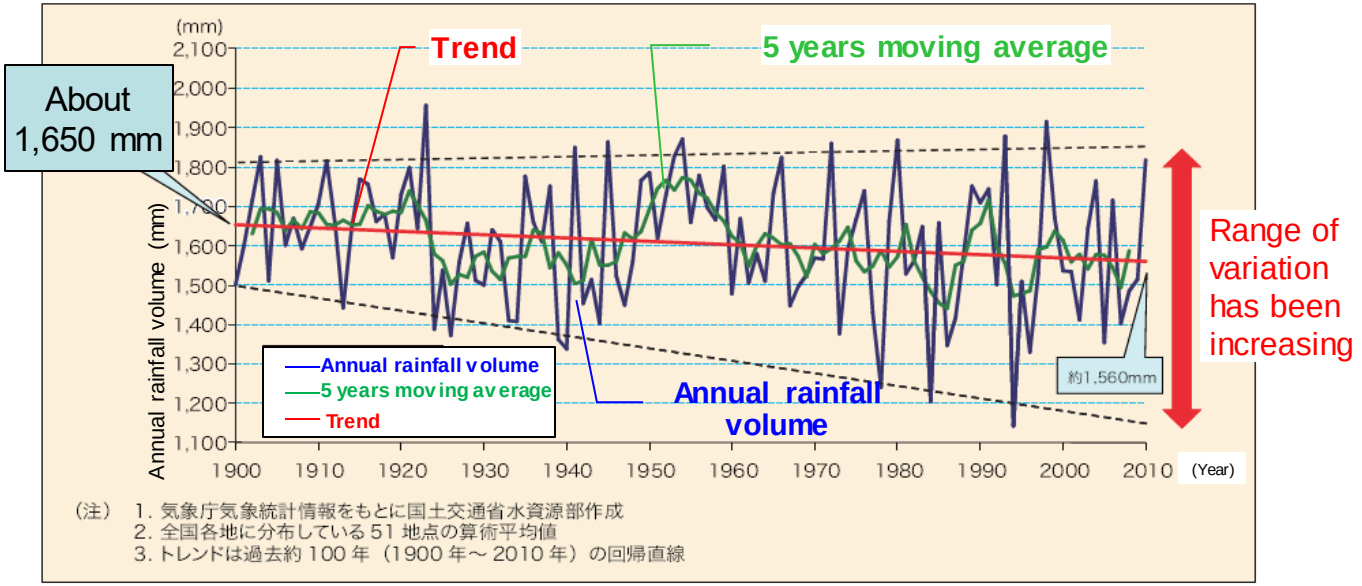
## Arch Dam

Kamishiiba Dam
110m height, built in 1955

# *Flood and drought are getting severer.*

- ✓ Flood and drought are getting severer.
- ✓ Water management became indispensable for sustainable socio-economy.

Annual variation of rainfall volume in Japan (1900-2010)




*Reference : Water Resources in Japan, MLIT (2013)*

# Dam Upgrading under Operation

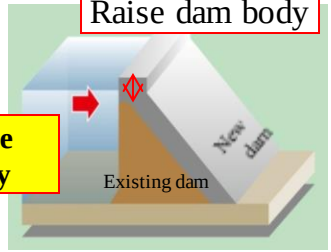
✓ Remake existing dams effective.
✓ Solve emerging problems like water shortage and flooding.
(Problems can be found through the dam inspections.)

## Capacity Enlargement

Dam body heightning

Raise dam body

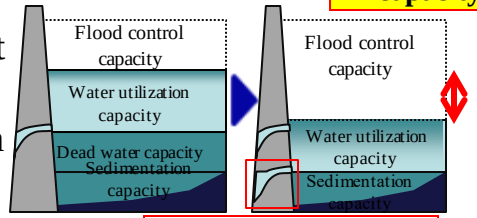
**Increase capacity**




## Capacity Transfer

**Increase capacity**

New outlet drilling under dam operation

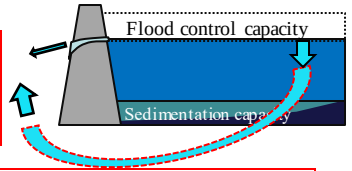



Adding new outlet

## Spillway Expansion

New tunnel spillway is installed

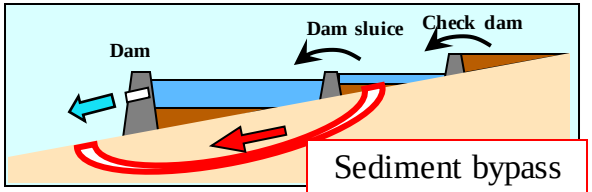
**Increase discharge capacity**




New large cross section water channel tunnel

## Dam Life Extention

Sedimentation is controlled by installing sediment bypass tunnel



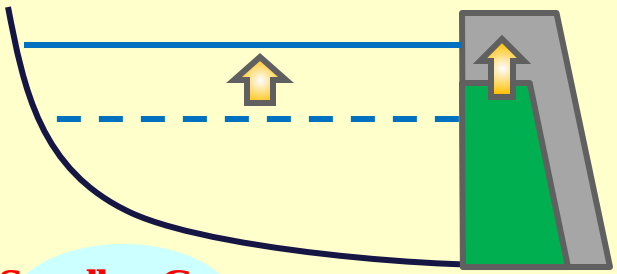

Sediment bypass channel

**Permanent sedimentation measures**

# Concept of Dam Upgrading

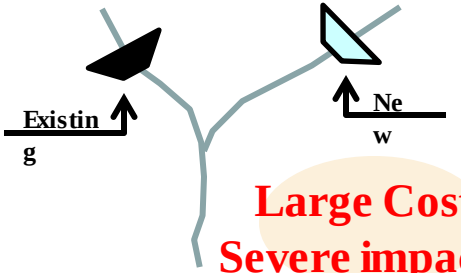
✓ Dam upgrading takes smaller cost than newly constructing a dam.
✓ Also it affects less on the local community and environment.

## Upgrading existing dam



**Smaller Cost,**
**Smaller impact***

## Constructing a new dam




**Large Cost,**
**Severe impact***

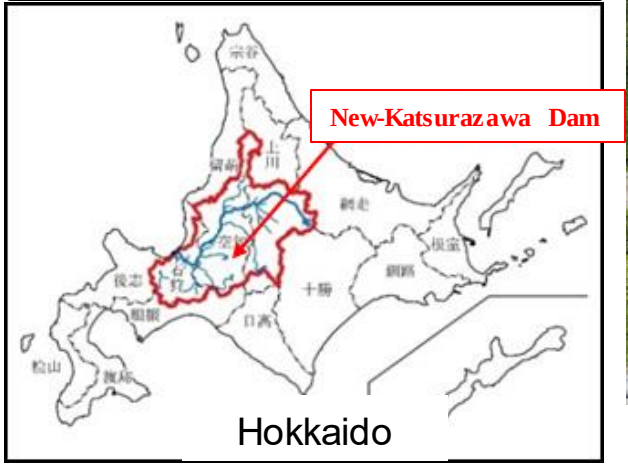
*(e.g.) Newly inundated land,
Substitute roads, Ecosystem

# Enlarging Capacity by Raising the Existing Dam Body

- As the New-Katsurazawa Dam, the capacity of existing Katsurazawa Dam is enlarged by raising the height
- By slightly raising the dam body (approx. 20%), the total storage capacity of the resernoir will be increased by 60%.

**New-Katsurazawa Dam**

- **Location:** Hokkaido
- **Purpose:** flood control, maintenance of normal water flow functions, municipal water, industrial water, hydropower
- **Specifications:** gravity concrete dam (New Height 75.5m, New storage capacity 147.3 million $m^3$)




**Capacity Enlargment**

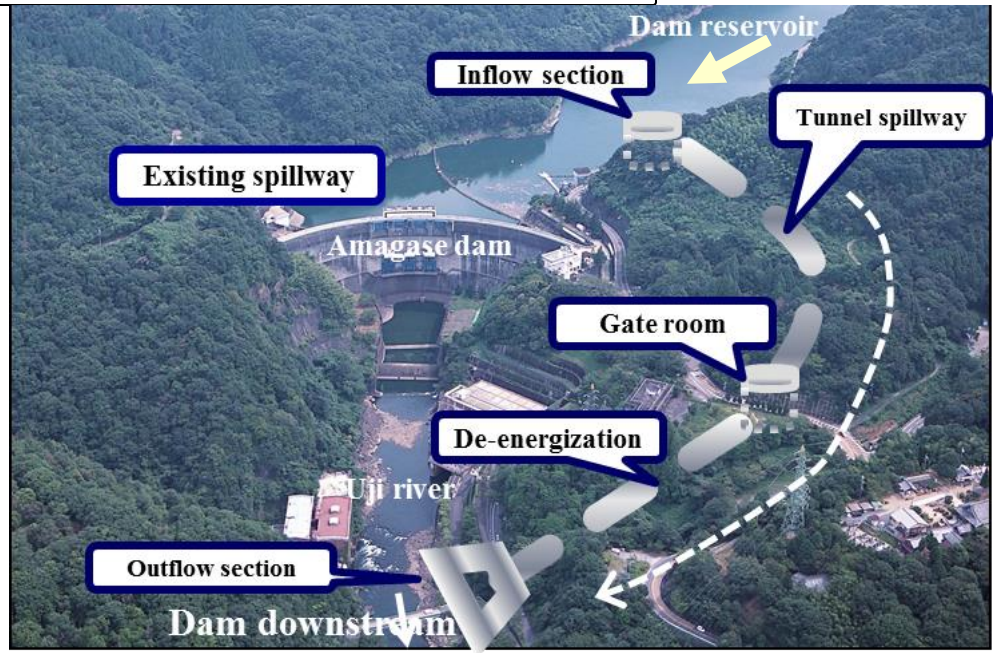
by raising the existing dam body

## *Additional Spillway to Increase the Flood Discharge*

✓ At the Amagase Dam, a tunnel-type flood spillway is newly installed.
✓ Increases the flood discharge and the flood control function without increasing the total capacity of the reservoir.

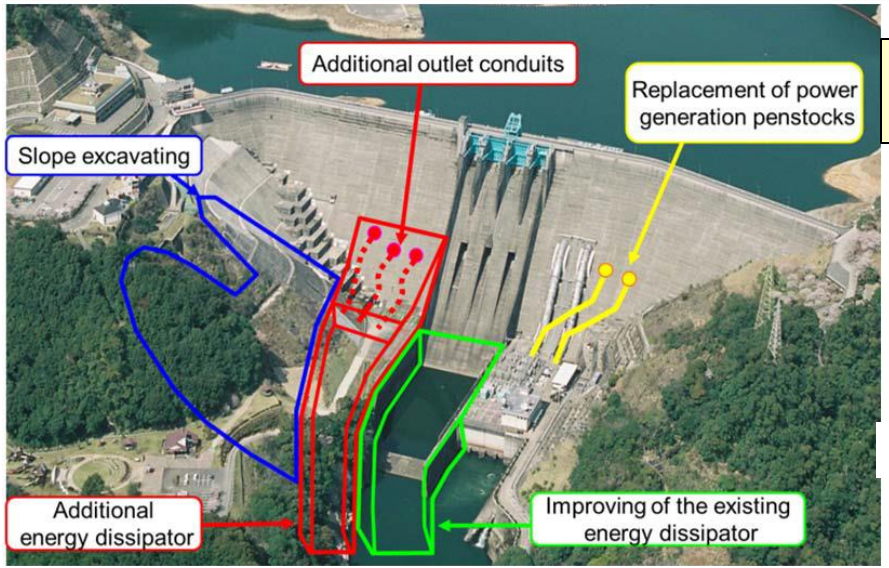
- **Location:** Uji City, Kyoto
- **Purpose:** Flood, municipal water supply, hydropower
- **Specifications:** Arch type concrete dam
  Height 73.0m, Total storage capacity 26.28 million $m^3$

| |
|---|
| Improving flood control function |
| Improving water utilization function |



# Dam Body Drilling Technologies for Dam Upgrading

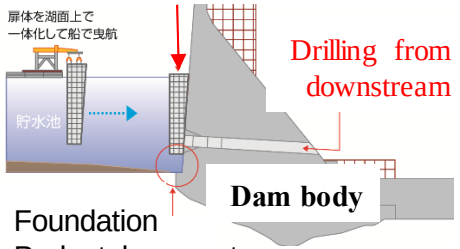
- ✓ At the Tsuruda Dam, constructing new discharge tunnel through the dam body to optimize the operation.
- ✓ Installing deep-water structures for re-arrange the active storage capacities without the restriction on the operational function of the existing dam.
- ✓ Significantly reduces underwater work, increases safety, and shortens the construction period.




Improving flood control function

By Dam Body Drilling

**Floating type coffering facility**



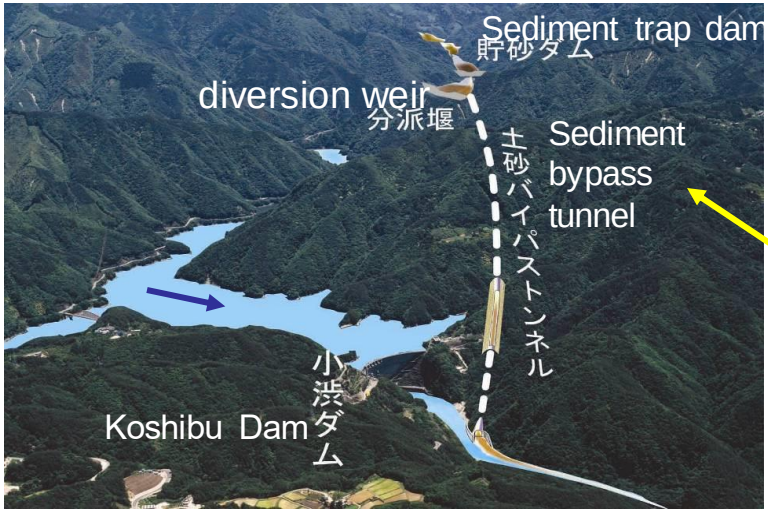

Foundation Pedestal concrete Is Not Required

# Dam Life Extension by Sediment Control Measures

✓ At the Koshibu Dam, sedimentation within dam's effective capacity is controlled to extend dam life by installing a bypass tunnel, etc.
✓ Allows sediment to be discharged downstream.

- **Location:** Nagano Prefecture
- **Purpose:** Control sedimentation in the reservoir, improve downstream river environment
- **Specifications:** arch type concrete dam
  Height:105m, Total storage capacity: 58 million $m^3$

| **Dam Life Extention** |
| --- |
| sediment transport by installing diversion weir and bypass tunnel |




Sediment bypass tunnel