3.6「日本における豪雨に起因する土砂災害」

国総研危機管理技術研究センター砂防研究室長

岡本　敦

Sediment-related Disasters induced by Heavy Rainfall in Japan

November 30, 2012

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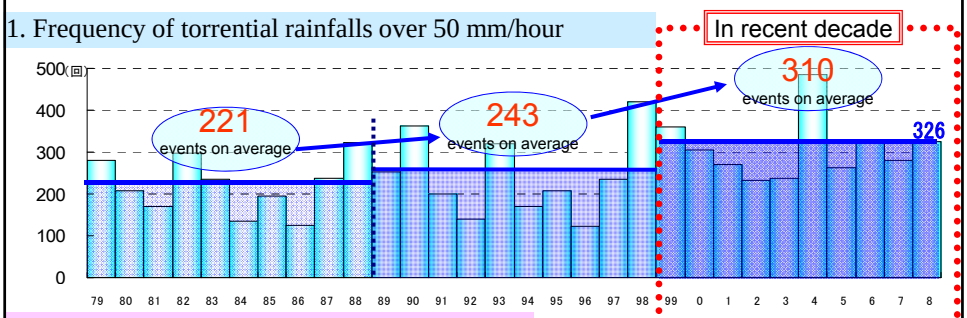
Research Center for Disaster Management,
National Institute for Land and Infrastructure Management, MLIT

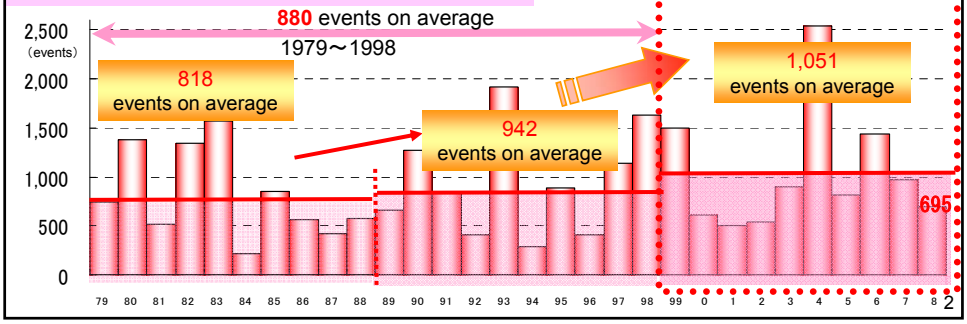
1

Increase of Torrential Rainfall and Sediment-related Disaster

1. Frequency of torrential rainfalls over 50 mm/hour



2. Number of disasters in the past 30 years



2

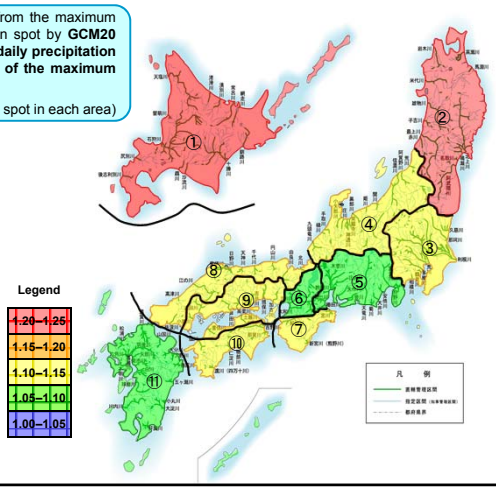
Change in Precipitation Due to Climatic Change Caused by Global Warming

- **At 100 years from now, precipitation will generally be 1.1 to 1.3 times as much as the present amount. It will be up to 1.5 times in some places.**
- **Estimation of the biggest amount of precipitation in the year at 100 years from now by dividing Japan into 11 areas shows that the rate of change will tend to be higher in Hokkaido and Tohoku.**

The future precipitation* is estimated by calculating X / Y from the maximum daily precipitation in the year obtained at each investigation spot by **GCM20 (A1B scenario)**, where X is the **average of the maximum daily precipitation between the years 2080 and 2099**, and Y is the **average of the maximum daily precipitation between the years 1979 and 1998**.

(* Median of distribution of averages at each investigation spot in each area)

①	Hokkaido	1.24
②	Tohoku	1.22
③	Kanto	1.11
④	Hokuriku	1.14
⑤	Chubu	1.06
⑥	Kinki	1.07
⑦	Southern Kii	1.13
⑧	San-in	1.11
⑨	Setouchi	1.10
⑩	Southern Shikoku	1.11
⑪	Kyushu	1.07



3

Example of debris flow and slope failures due to torrential rainfall in Japan

Yamaguchi Prefecture ／July 21,2009

Kumamoto Prefecture ／July 12,2012

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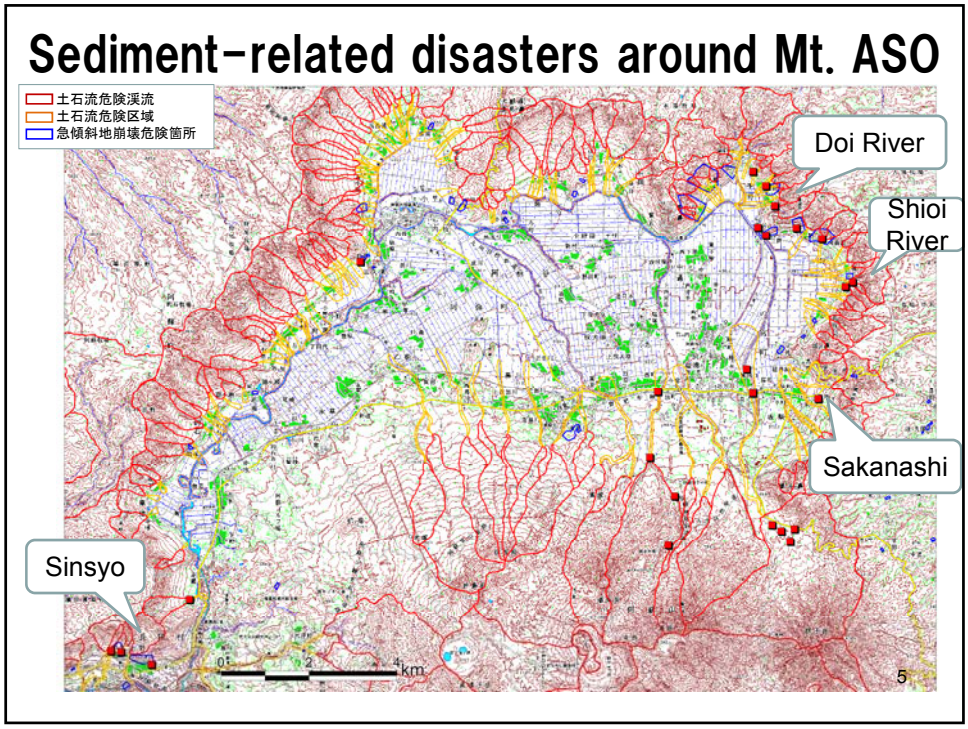
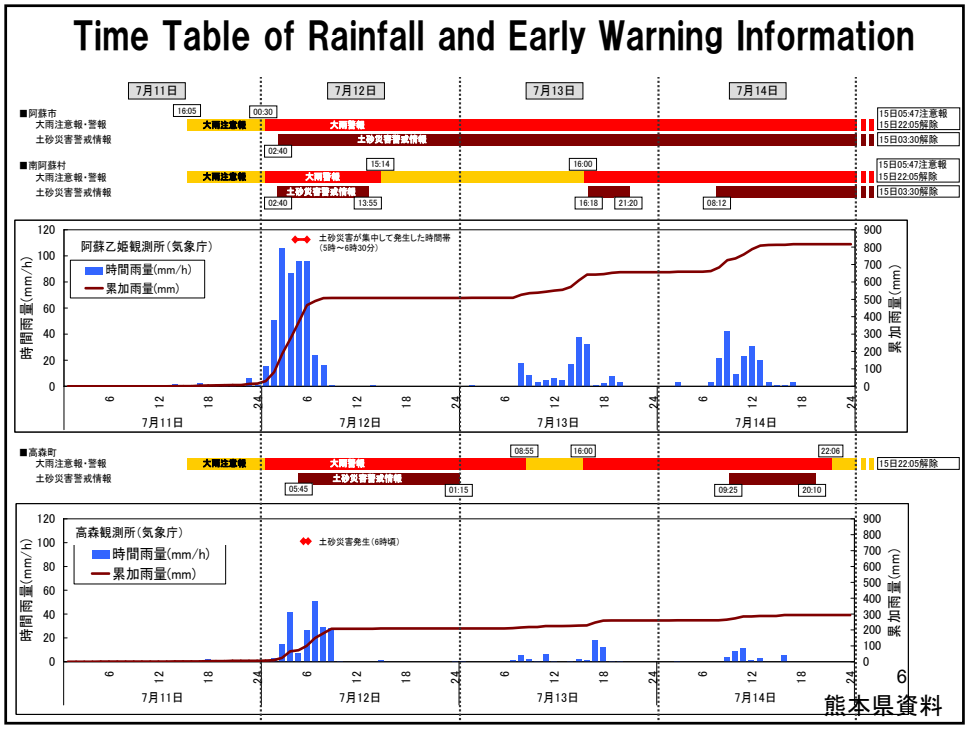

Sediment-related disasters around Mt. ASO
土石流危険渓流
土石流危険区域
急傾斜地崩壊危険箇所
Doi River
Shioi River
Sakanashi
Sinsyo
0
2
4km
5


Time Table of Rainfall and Early Warning Information
7月11日
7月12日
7月13日
7月14日
■阿蘇市
大雨注意報・警報
土砂災害警戒情報
16:05
00:30
02:40
15日05:47注意報
15日22:05解除
15日03:30解除
■南阿蘇村
大雨注意報・警報
土砂災害警戒情報
15:14
16:00
02:40
13:55
16:18
21:20
08:12
15日05:47注意報
15日22:05解除
15日03:30解除
阿蘇乙姫観測所（気象庁）
時間雨量(mm/h)
累加雨量(mm)
土砂災害が集中して発生した時間帯
（5時～6時30分）
時間雨量(mm/h)
累加雨量(mm)
■高森町
大雨注意報・警報
土砂災害警戒情報
08:55
16:00
22:06
05:45
01:15
09:25
20:10
15日22:05解除
高森観測所（気象庁）
時間雨量(mm/h)
累加雨量(mm)
土砂災害発生（6時頃）
6
熊本県資料

Slope Failure at Sinsyo District, Minami-aso Village

・Slope Failure Size (approx.); width 40m, length 150m, height 60m, depth 1m
・Collapsed sediment deposited behind the retaining wall, thus preventing house damage.
・Retaining wall and stone-guard were partially broken.

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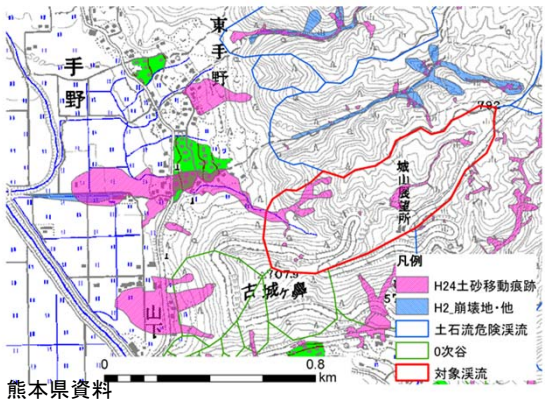
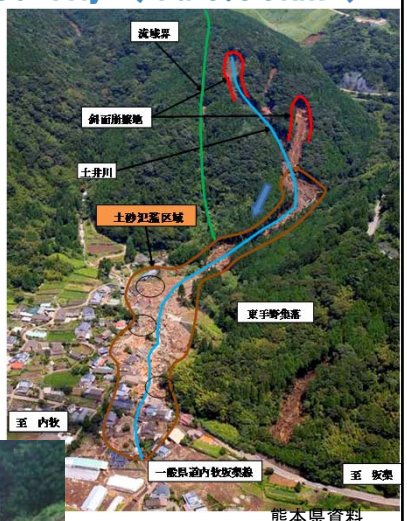
Doi River in Ichinomiya Town, Aso City （Ca:0.35km²）



熊本県資料



熊本県資料

・14 houses were totally or partially destroyed by the debris flow.

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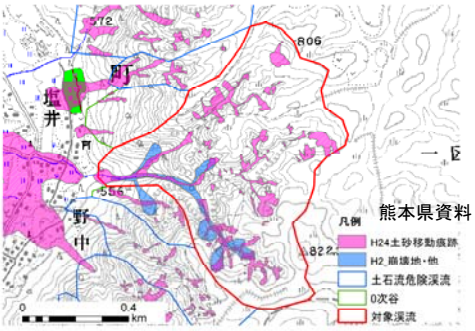
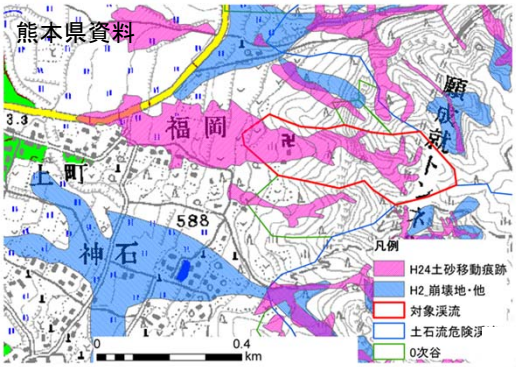
Shioi River in Ichinomiya Town, Aso City（Ca:0.49km²）



・7 houses were totally destroyed.
・Sabo dam caught part of debris flow and minimize the damage downstream.

Sakanashi District, Aso City（Ca:0.09km²）



・7 houses totally destroyed, 6 people dead.
・Collapse at hollow of the slope flowed like debris flow.
・Deposited materials mainly consist of volcanic ash. And they also include boulders and drift wood.

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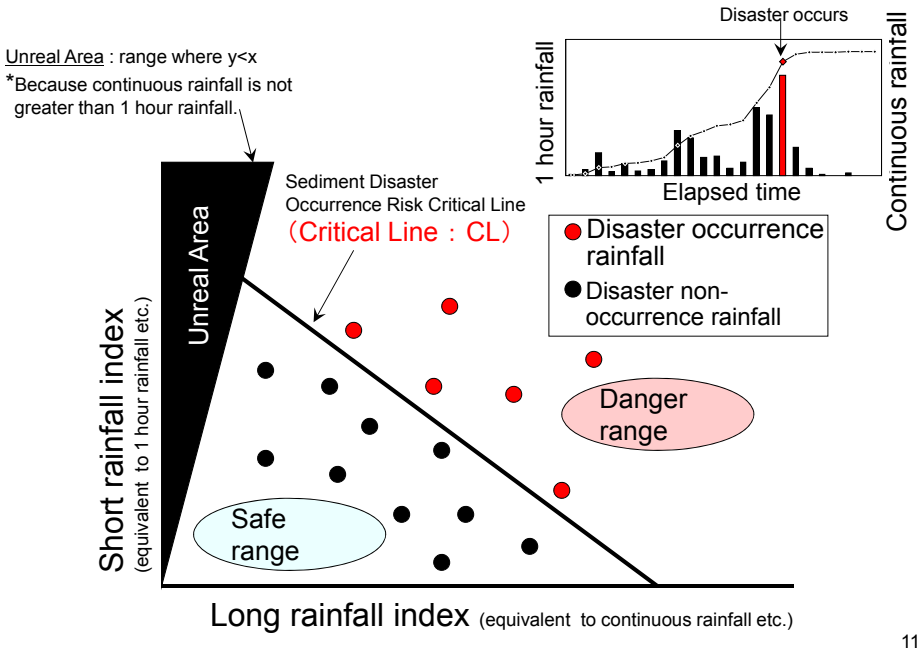
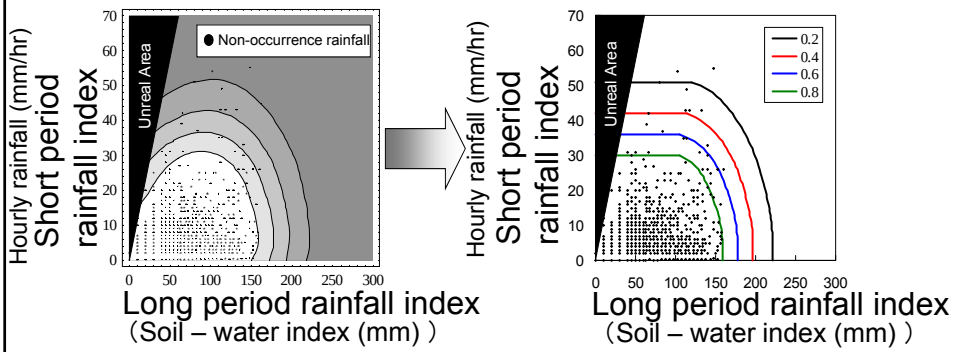
Concept of how to make standard of early warning information



11

Study of a new CL setting method

From the response curved surface set based on non-occurrence rainfall, an optional same probability value line is abstracted (slightly corrected to prevent contradiction with phenomenon)



An same probability value line judged to be suitable according to its relationships with the false alarm rate, frequency warnings are issued, and rainfall warnings is set.

⇒ Objective CL can be easily set.

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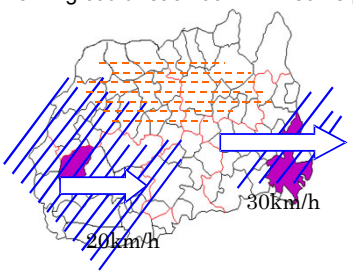
Example of sediment disaster warning information

Sediment disaster warning information for AA Prefecture, item No. X

Time: △△ Date:□□□□
Joint announcement by AA Prefecture and BB Regional Weather Observatory

Municipality in which warning issued: CC district, DD City

It is expected that the danger of sediment disaster due to heavy rains will rise significantly within the next two hours. Please take thorough steps to provide warning in sediment disaster-prone areas and surrounding areas. It is expected that the maximum rainfall in municipalities targeted by this warning could reach 60 mm in some places over the next three hours.



Explanation

- Municipality in which warning
- Region in which seismic intensity was ?? or more during the EE Earthquake
- Area of actually measured heavy rain (30 mm per hour or more)
- Length of arrow corresponds to hourly movement distance

For inquiries, please contact:
Sabo Office, AA Prefecture: 111-111-1111
BB Regional Weather Observatory: 222-222-2222

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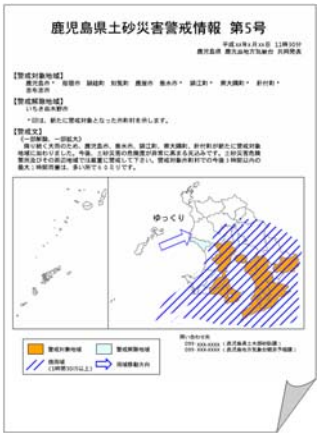
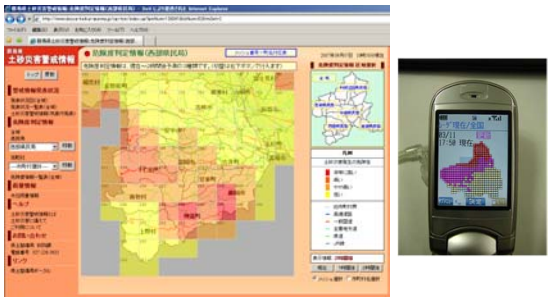
Procedure for Issuing Sediment Disaster Warning Information

1. Fax and internet (PDF file) information



Information of rainfall forecast and the name of region (city, town or village) which exceeds the warning level

2. Internet or cellular phone information



Detailed Information of rainfall forecast and the warning level of the 5×5km mesh

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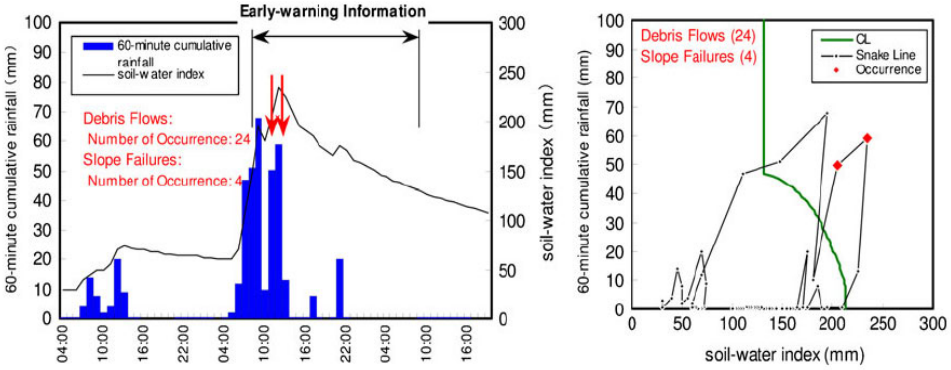
Example of snake line progress using RBFN

• On 21st July 2009, 65 debris flows and 105 slope failures occurred in Yamaguchi Prefecture.
• 14 people died as a result of these mass movements.
• The time series of 60-min rainfalls and soil–water index, the timings of occurrence of debris flows and slope failures, and the period of early-warning information issue are shown in the left figure.
• The progress of the snake line and the timing of the disasters (red box) in the damaged area are shown in the right figure.



→CL adequately captured the timing of these disasters occurrences

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Past 4 years operation of sediment disaster warning information system

	2008	2009	2010	2011	average
Warning information announcement	1012	906	895	1442	1064
Total number(upper)					
Number in each area(lower)	0.58	0.52	0.51	0.98	0.63
Warning announced & disaster occurred	23	34	36	55	37
Number(upper)	2.3%	3.8%	4.0%	3.8%	3.5%
Incidence rate(middle)	71.9%	69.4%	73.5%	82.1%	75.1%
Capture rate(lower)					
Warning not announced & disaster occurred	9	15	13	12	12
Number(upper)	28.1%	30.6%	26.5%	17.9%	24.9%
Undetected rate(middle)	—	8	10	10	9
Cases that not exceeded CL(lower)					

Note:
(1) Incidence rate: The ratio of cases that disaster occurred when warning information being announced.
(2) Capture rate: The ratio of cases that warning information being announced when disaster occurred.
(3) Undetected rate: The ratio of cases that disaster occurred when warning information not being announced.

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Hydrological and Sediment Transport Observation in Mountain River

All MLIT SABO Offices have started “Hydrological and Sediment Transport Observation in Mountain River”. NILIM has studied methodologies to gauge, and provided technical guideline and supports for the SABO Offices.

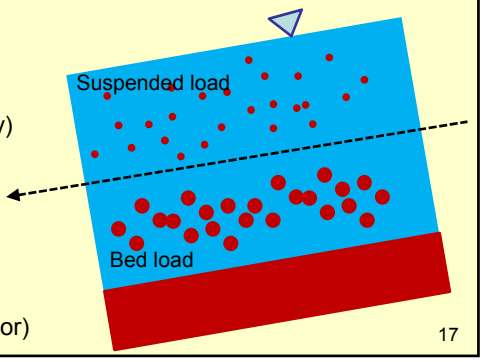
Purposes of the observation;
1) Monitoring sediment load in a watershed
2) Establishment and Evaluation of SABO master plan in a watershed
3) Estimation of runoff coefficient in mountain rivers
(ex. Estimation of water level of landslide-dam -> Early warning downstream)
4) Establishment of comprehensive sediment management plan for national land conservation

Items of observation

A) Hydrological observation
- Precipitation
- Water discharge (Water level and velocity)

B) Suspended load observation
- Gauging by a turbidity meter
- Gauging by sampling river water

C) Bed load observation
- Gauging by a hydrophone (acoustic sensor)



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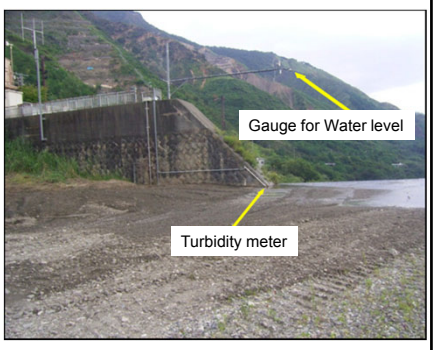
B) Suspended load observation
Gauging by turbidity meter and sampling river water

1) Calibration of turbidity meter with known turbid water made of river bed materials near the meter

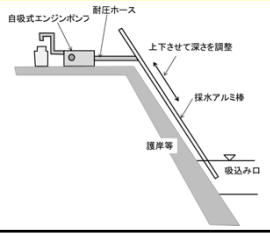
2) Gauging turbidity

3) Converting turbidity to density of suspended load

4) Calculation volume of suspended load by multiplying density of suspended load by water discharge



Pump for sampling river water



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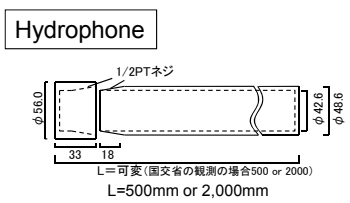
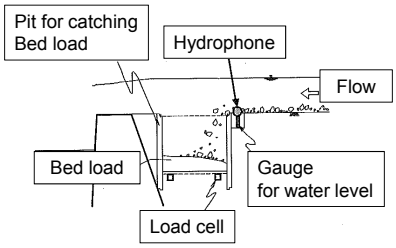
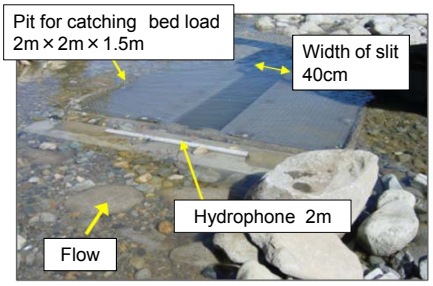
C) Bed load observation
- Gauging by a hydrophone

1) Picking up sounds of collision of bed load on a steel pipe by microphone
2) The sounds is recorded on a data logger as acoustic data
3) Converting the acoustic data to the volume of bed load







It is preferable to conduct calibration of the volume of bed load from Hydrophone by using volume of bed load caught by pit.

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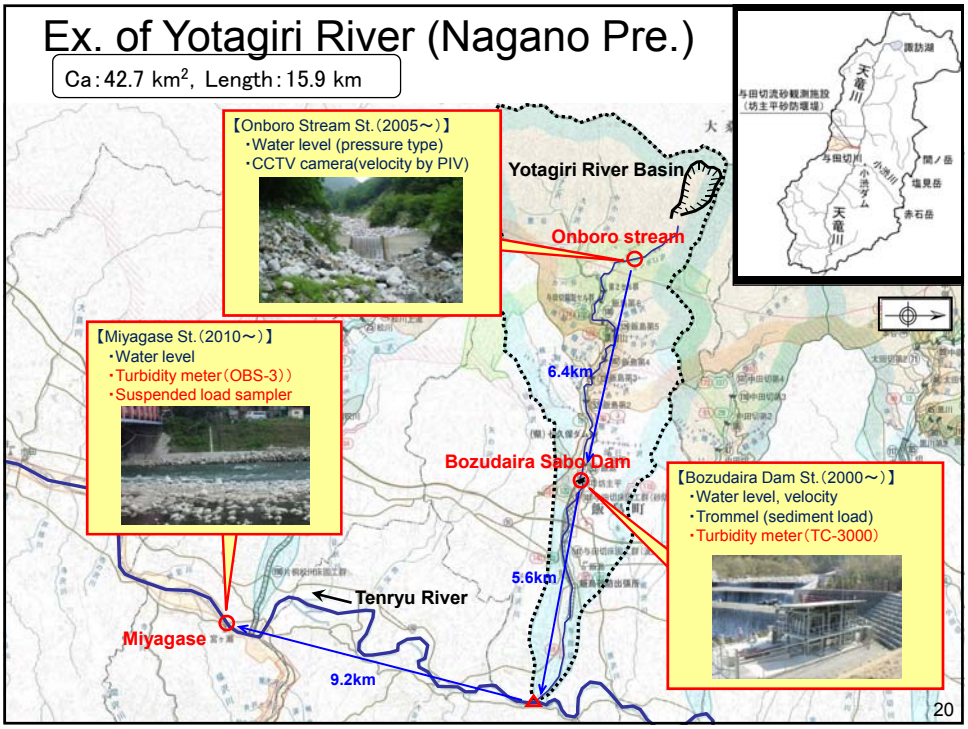
Ex. of Yotagiri River (Nagano Pre.)

Ca：42.7 km^2, Length：15.9 km



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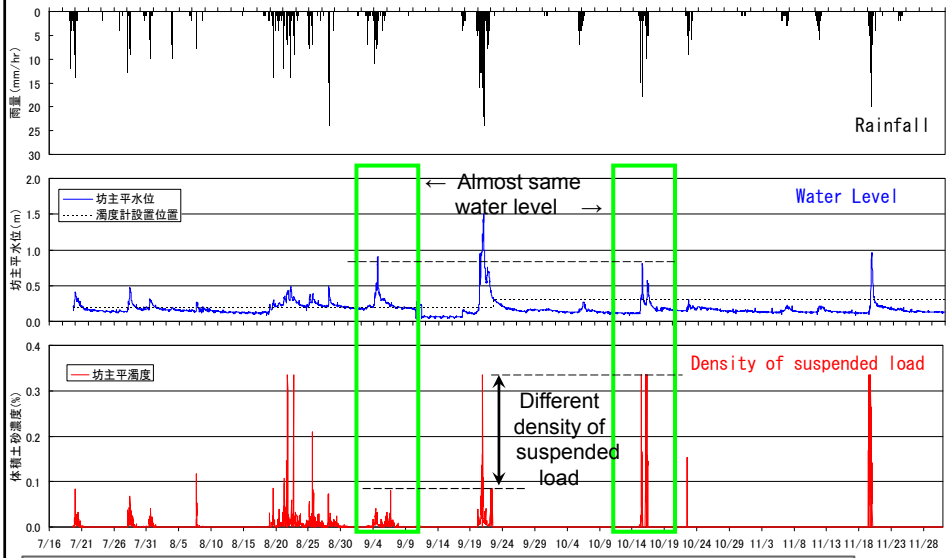
Data of Tubidity at Bozudaira Sabo Dam St.



- Almost same water level but different density of suspended load.
- 4 Sep. 0.08% 15 Oct. 0.03%

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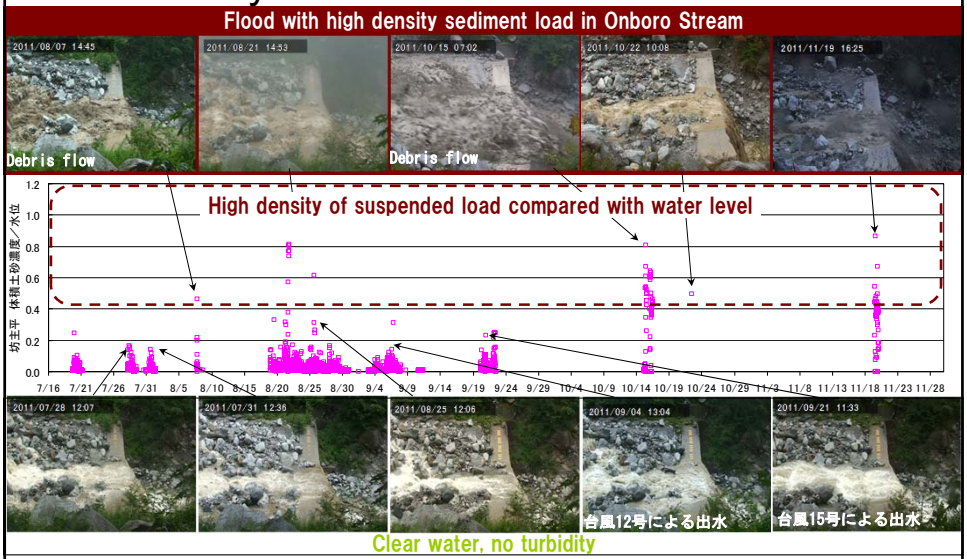
Density / Water Level at Bozudaira St.



Density/Water level at Bozudaira St. relates to Onboro stream condition.
⇨ Turbidity observation downstream could assume sediment production upstream.

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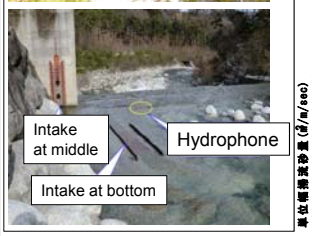
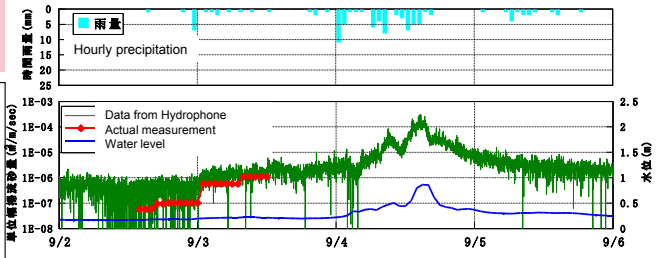
Example of Bed Load Observation : Bozudaira Sabo Dam

Comparison between the data from Hydrophone and actual measurement

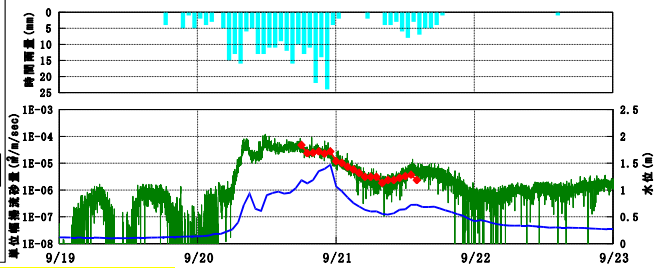
Facility of actual measurement

Trommel





Typhoon 12, 2011



Typhoon 15, 2011

The data from Hydrophone corresponded with the data of actual measurement.

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Thank you for your attention

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