Landslides and debris flow, and their countermeasures for enhancing resilient society

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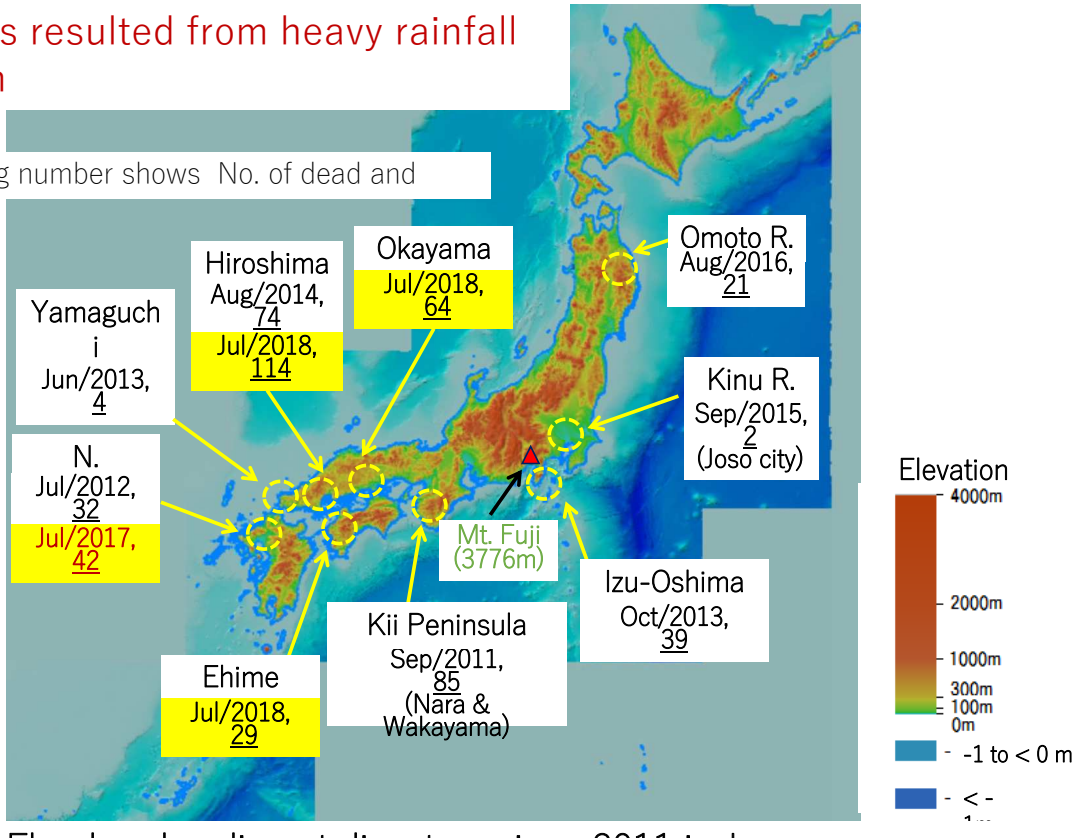
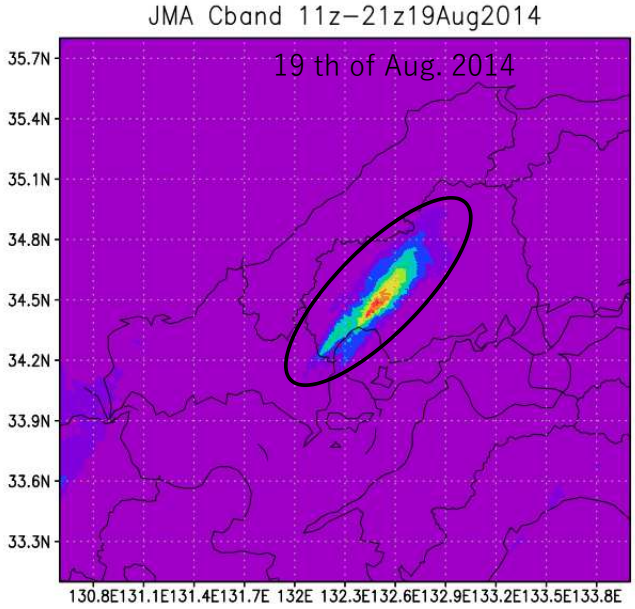
Contents

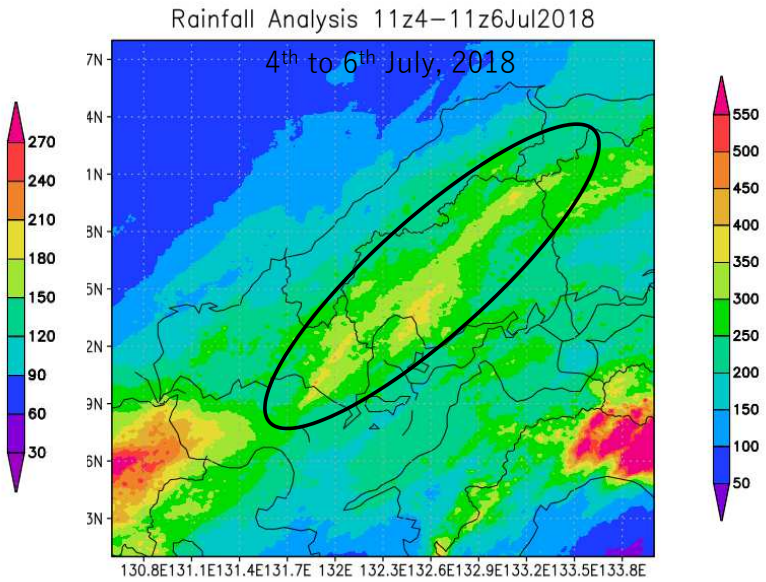
Recent disasters resulted from heavy rainfall events in Japan

✓ Each underlining number shows No. of dead and missing.



Flood and sediment disasters since 2011 in Japan

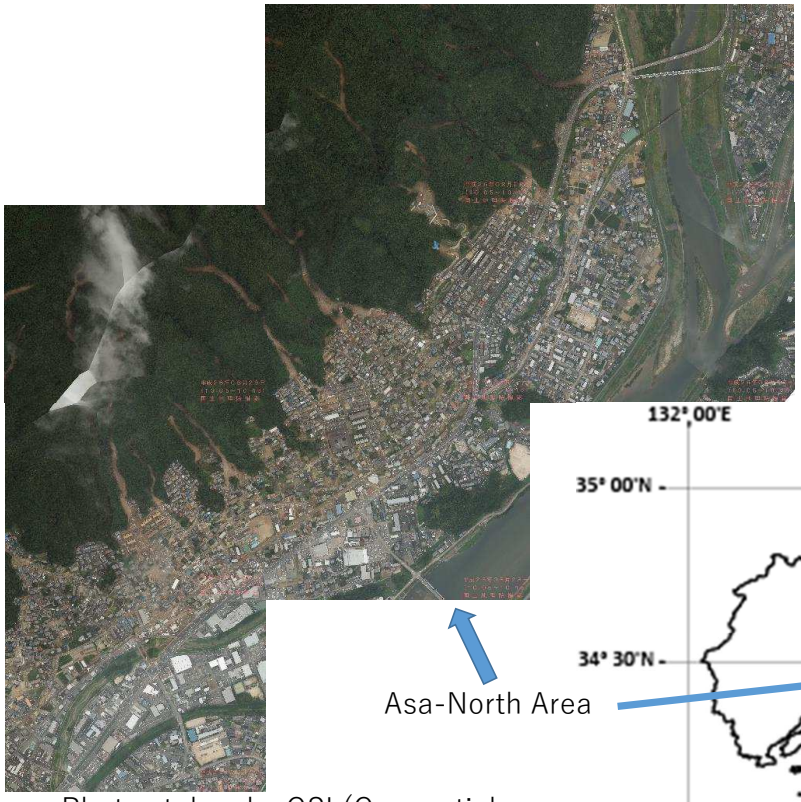




S/COLA

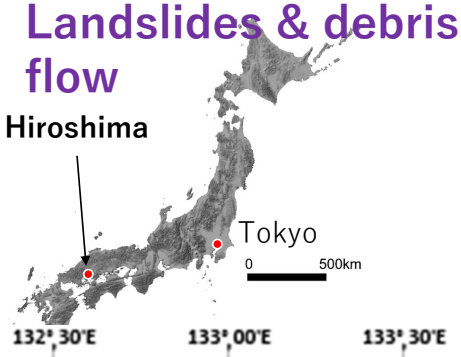
Data provided by Japan Meteorology Agency (JMA)

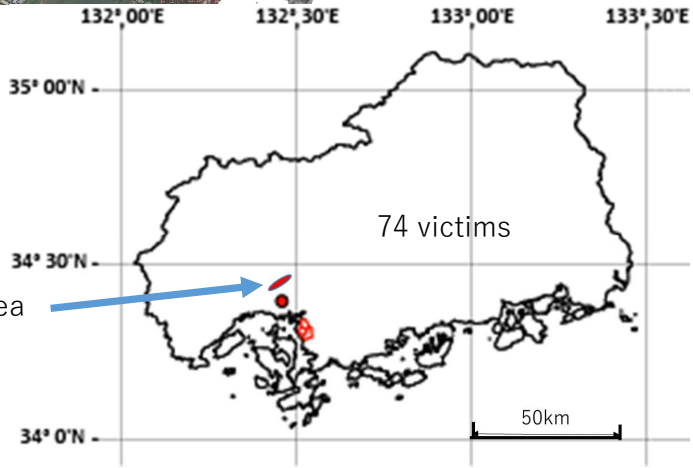
Rainfall events in the sediment disasters at Hiroshima



Photos taken by GSI (Geospatial Information Authority of Japan)

2014 Hiroshima Landslides & debris flow

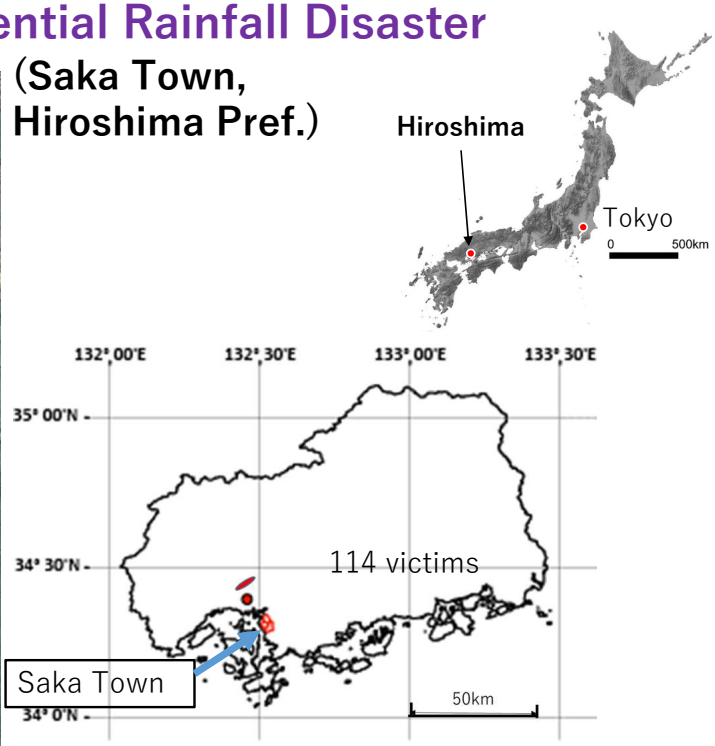




Asa-North Area

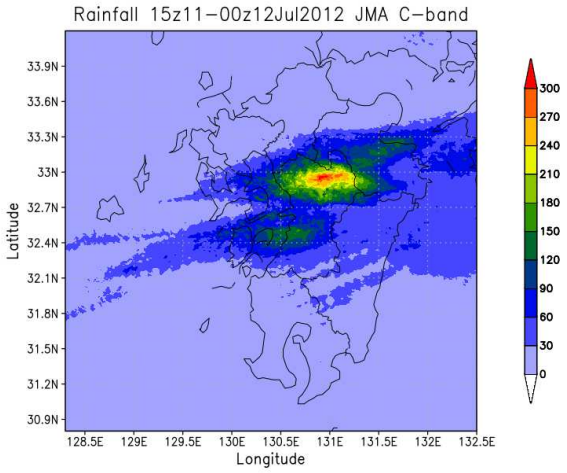
2018 Western Japan Torrential Rainfall Disaster

(Saka Town, Hiroshima Pref.)

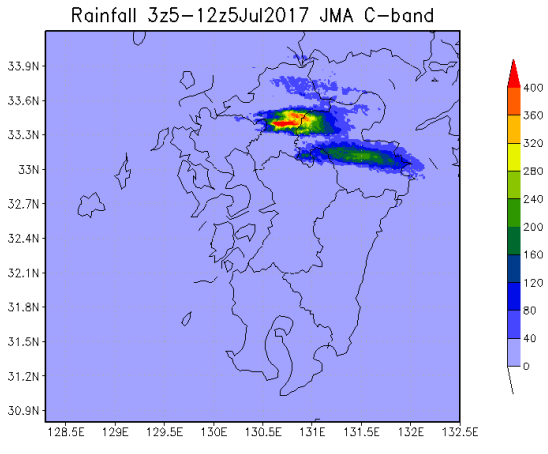


Prepared by GSI

July 2012



July 2017

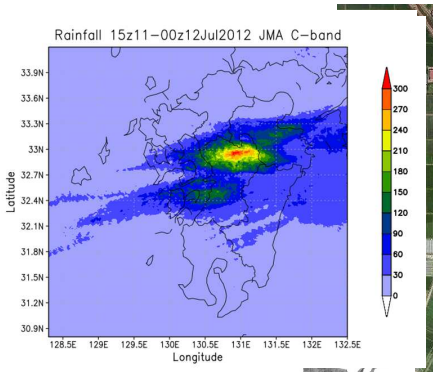


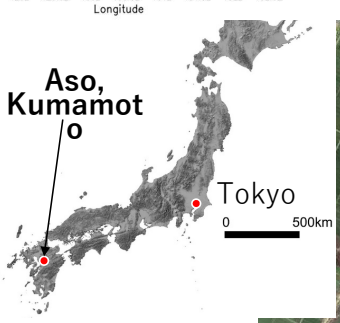
Data provided by Japan Meteorology Agency (JMA)

Northern Kyusyu

2012 Northern Kyushu Torrential Rainfall Disaster

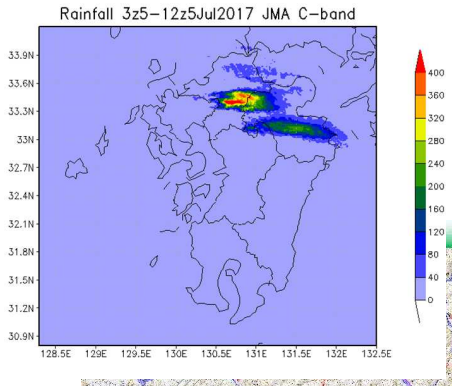
32 victims



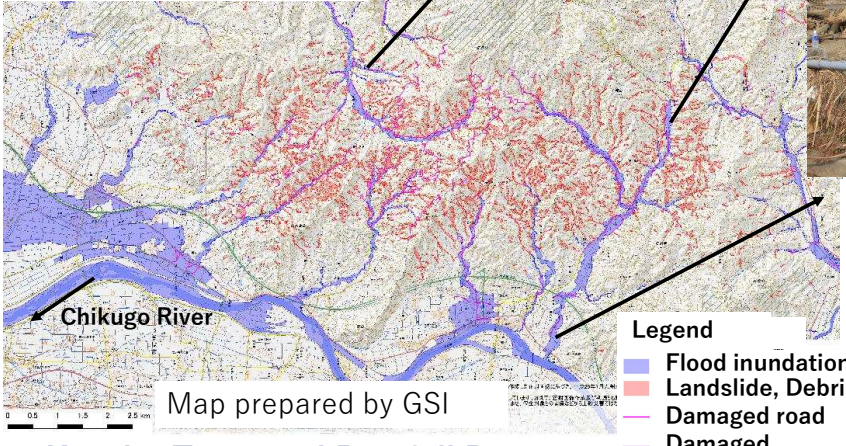


Prepared by GSI

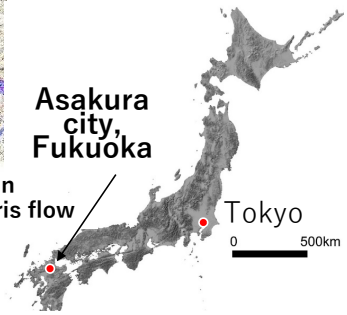
(Aso volcanic area, Kumamoto Pref.)



Photos taken by ICHARM



Map prepared by GSI



42 victims

2017 Northern Kyushu Torrential Rainfall Disaster

Summary

Occurrence density of landslides and debris flow ← reflected ← Temporal, spatial characteristics of rainfall

→ Due to climate change,

Disaster may take place more frequently,
and in addition,
it may take place even in areas where sediment disaster have not ever been experienced.

There have been some devastating cases where sediment disasters took place in two adjacent regions only several years apart. →
- Many residences in hazardous areas
- Difficulties of evacuation behaviors

Sediment runoff processes associated with occurrences of landslides

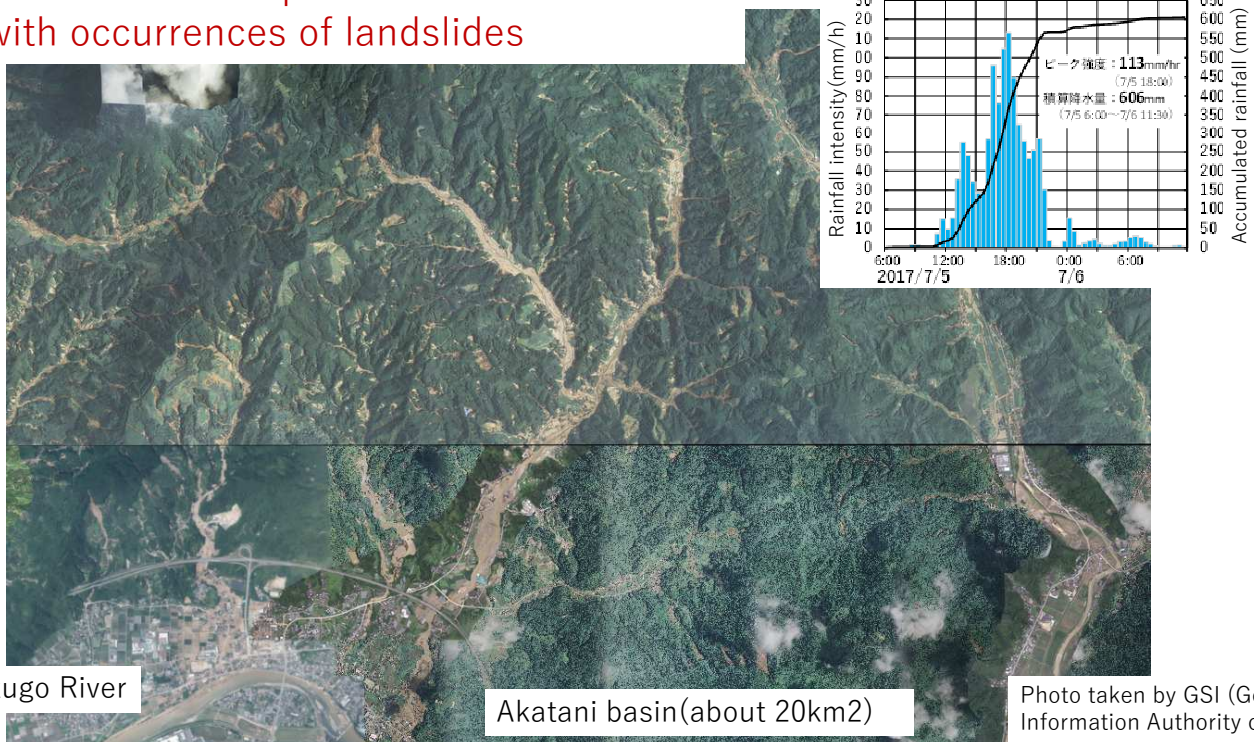
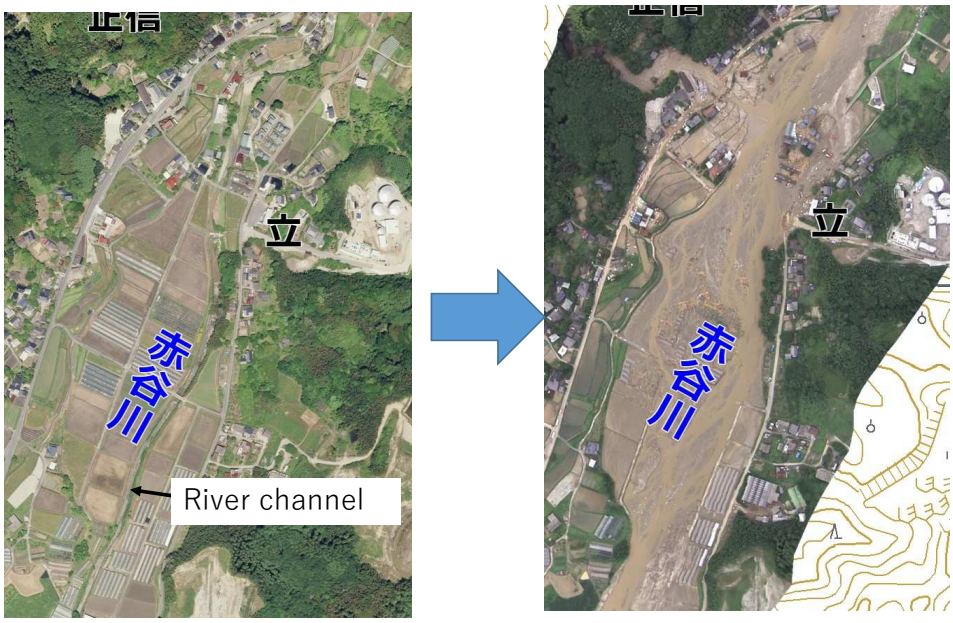


Photo taken by GSI (Geospatial Information Authority of Japan)

Severely damaged due to sediment runoff by landslides and debris flow in Akatani basin (Northern Kyushu - severe rainfall event in July, 2017)

Debris flow deposition in the upstream of Akatani basin

Damaged houses due to debris flow



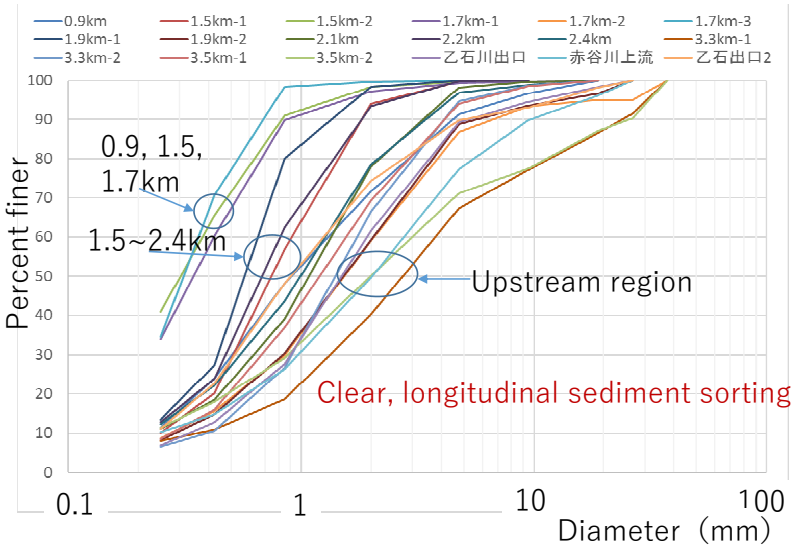
Before the flood　　Immediately after the flood

Channel change in the middle reach of Akatani

Photos taken by GSI (Geospatial Information Authority of Japan)

A huge amount of sediment deposited in the downstream reach of Akatani

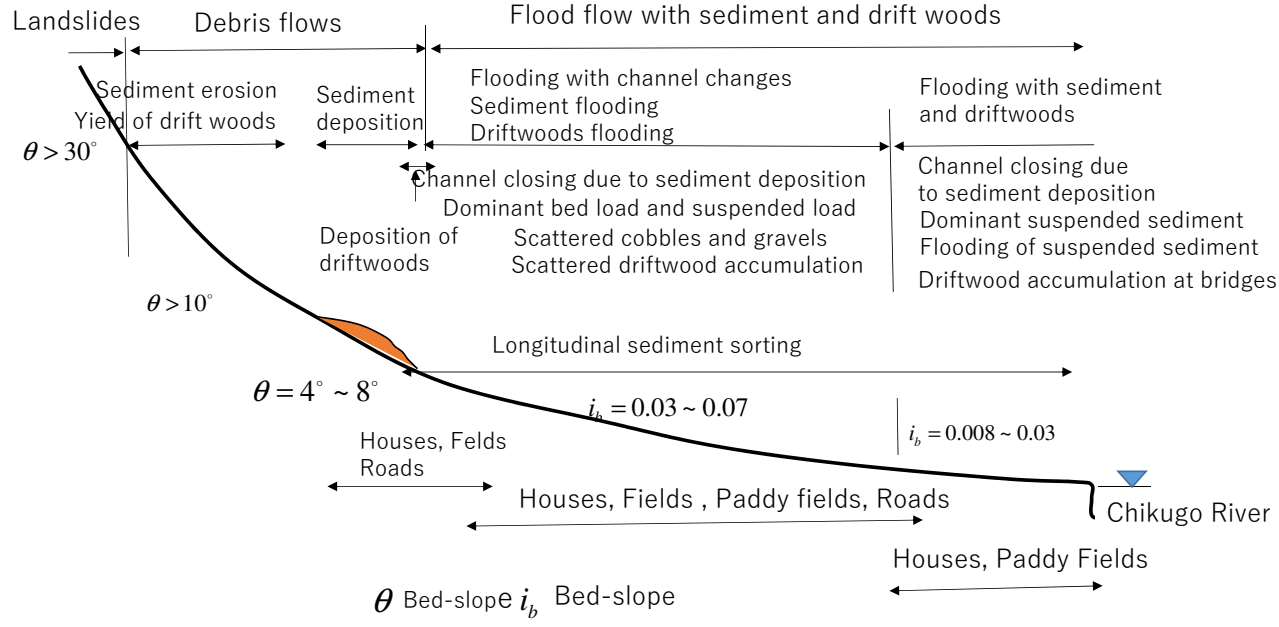
Sediment sampling sites for sieve analyses



Sediment particle sizes along the Akatani reach

(2017 event in Nothern Kyusyu)

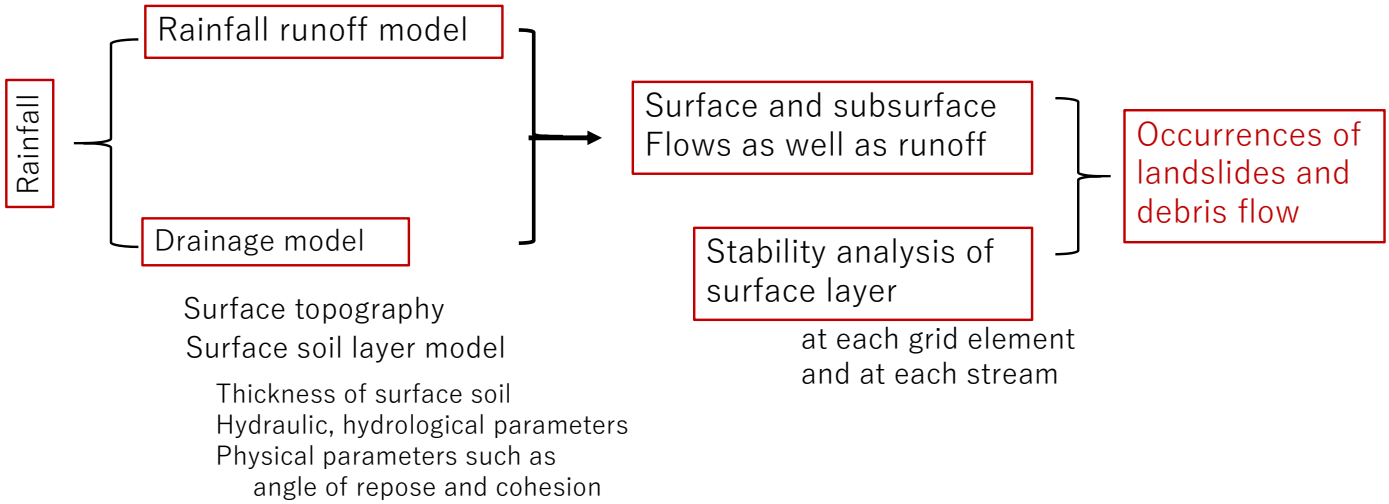
summary



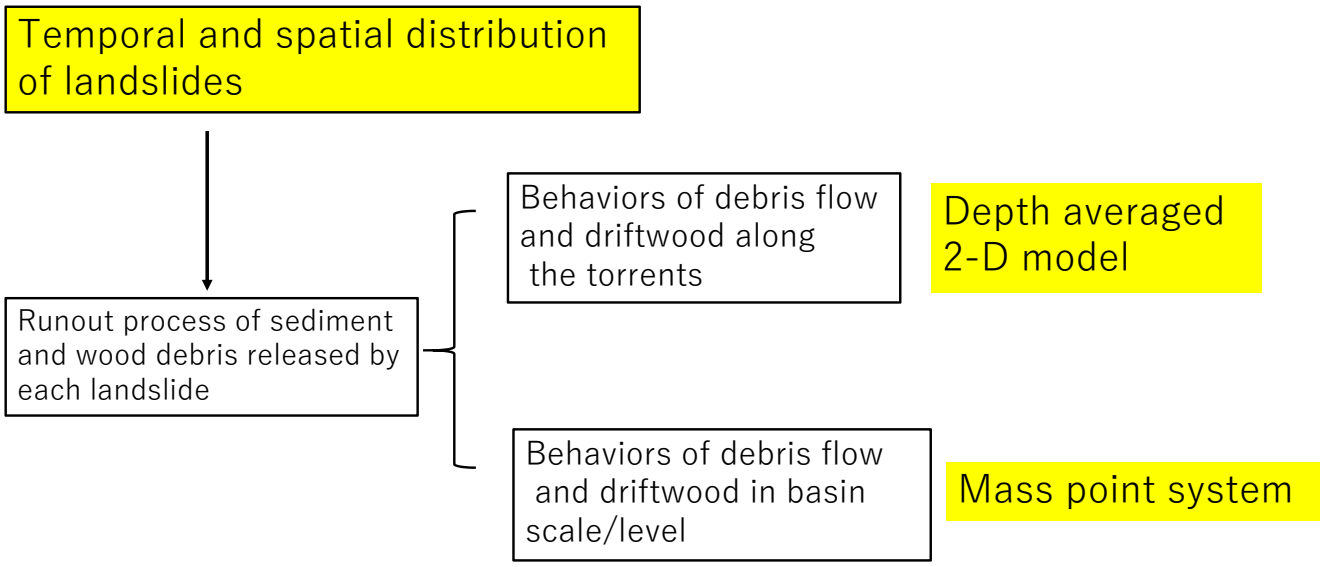
Sediment runoff processes and hazards resulted from the rain fall event at northern Kyusyu in July 2017

Methods for evaluating occurrences of landslides and debris flow, debris flow behaviors and flood flow with channel changes and drift wood

(1) Occurrences of landslides and debris flow



(2) Run-out processes of sediment and wood debris released from landslides



(3) Flood flow with active sediment transportation and drift wood

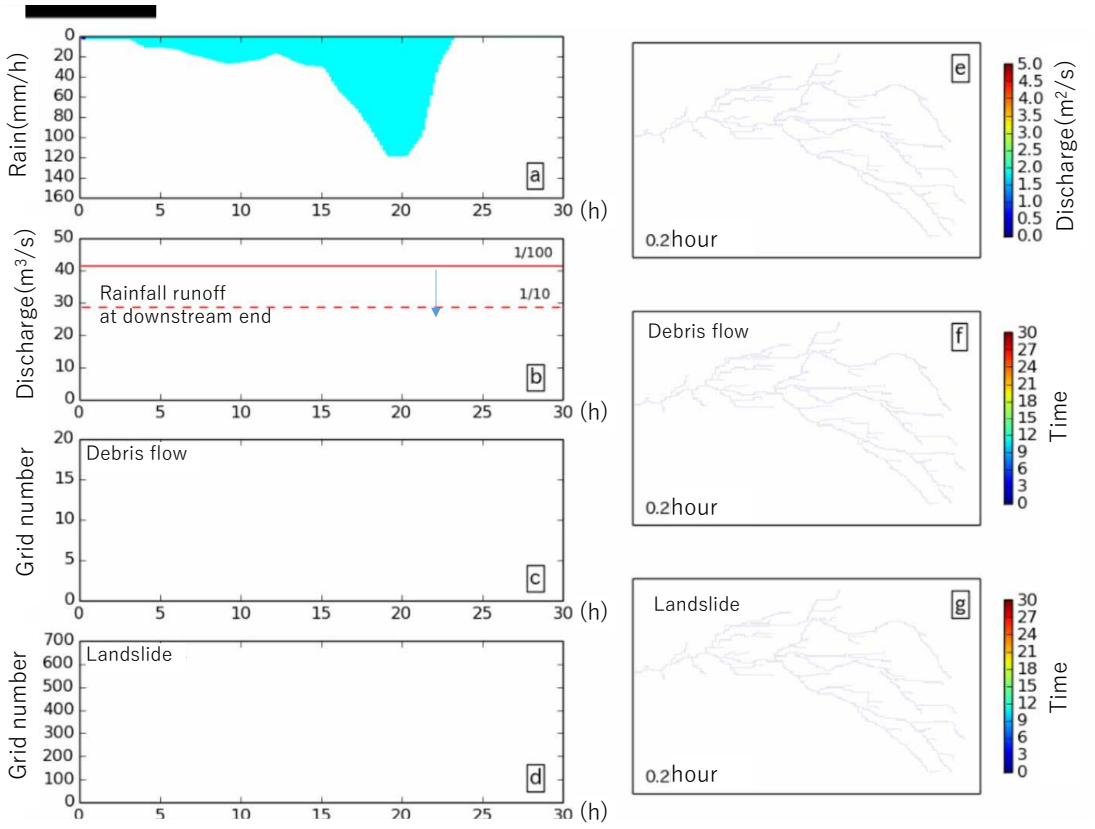
Depth averaged 2-D governing equations are employed;

Mass and momentum conservation equations for flood flow

Mass conservation equations of sediment and drift wood in flow body as well as in bed

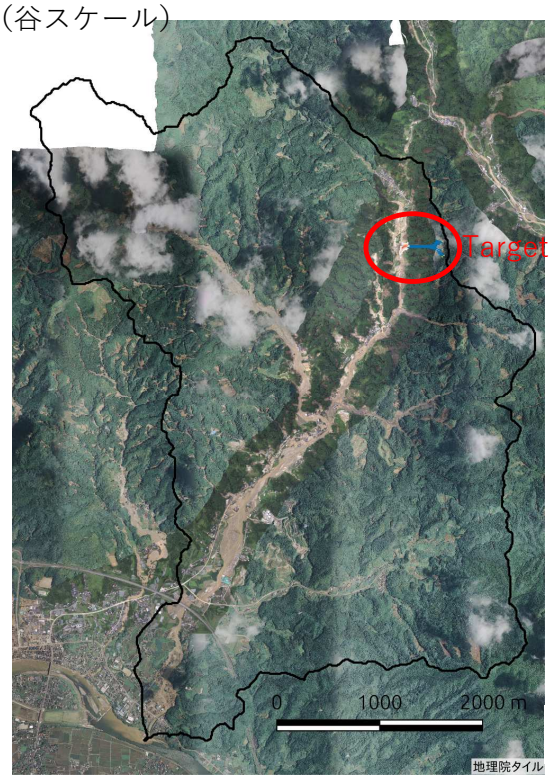
Bed-load formula
Layer model to predict sediment particle size distribution of bed sediment
Erosion / deposition rates of suspended sediment and wash load

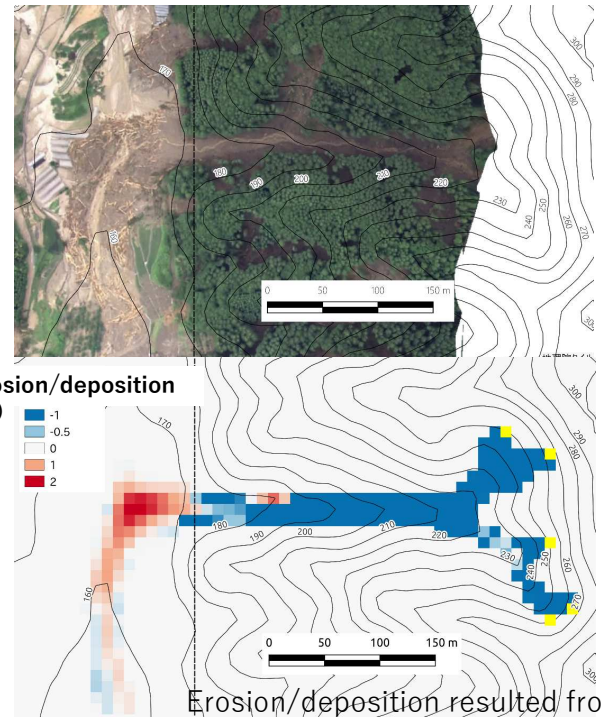
Numerical models need to evaluate
non-equilibrium behaviors of suspended sediment and wash-load,
longitudinal and lateral sediment sorting,
channel changes such as stream bifurcation



Izu-oshima event
2013
(Yamazaki et.al 2017)

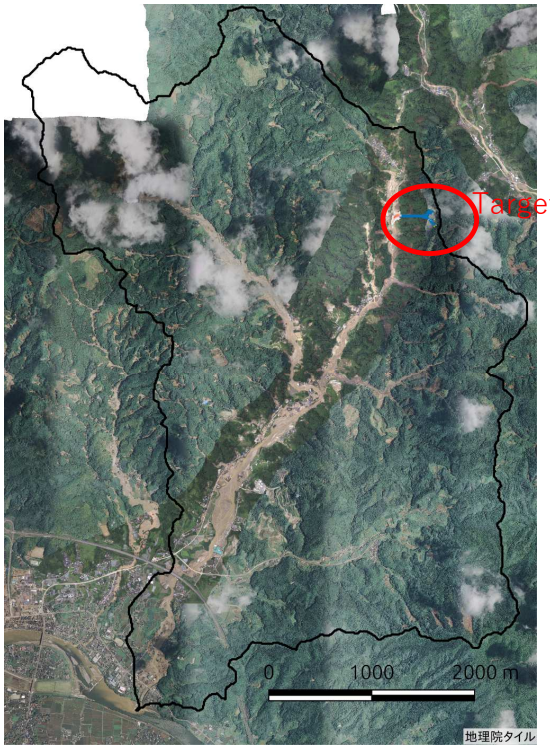
（谷スケール）

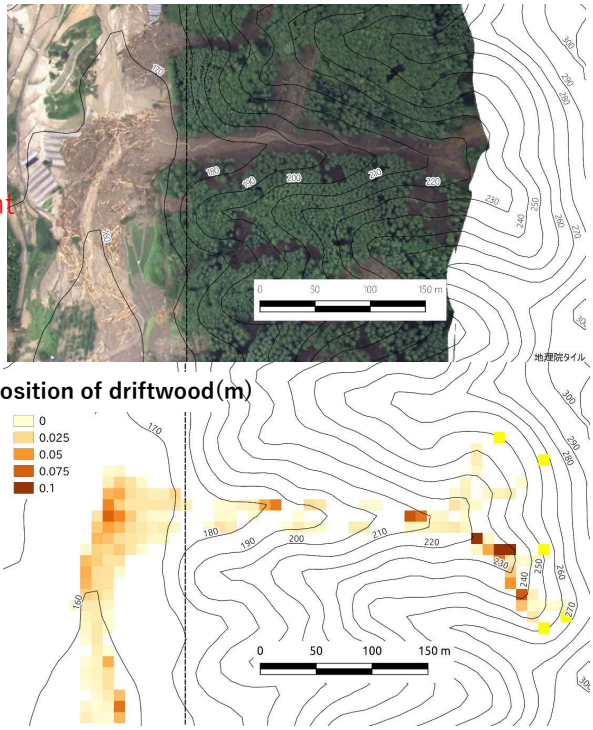




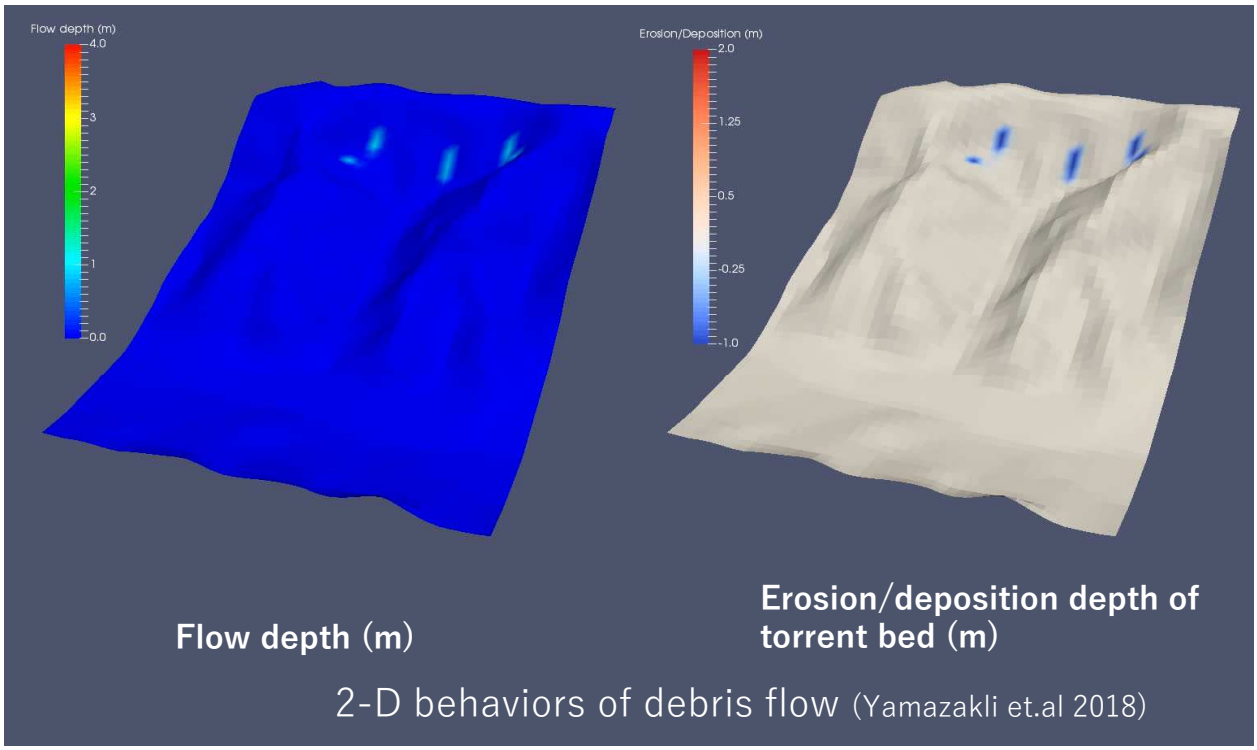
Erosion/deposition resulted from run-out process of debris flow

Debris flow simulation by means of 2-D model (Yamazaki et.al 2018)





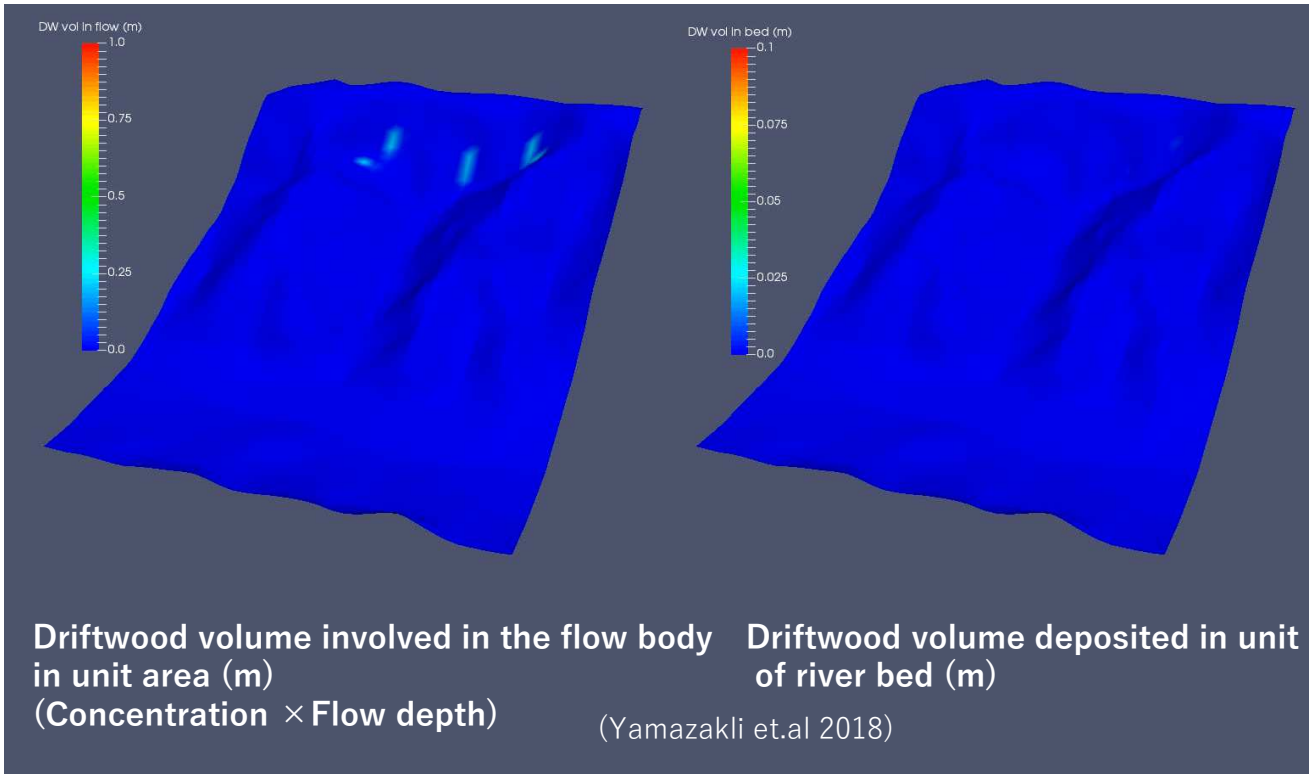
Deposition of driftwood carried by debris flow (Yamazaki et.al 2018)



Flow depth (m)

Erosion/deposition depth of torrent bed (m)

2-D behaviors of debris flow (Yamazakli et.al 2018)

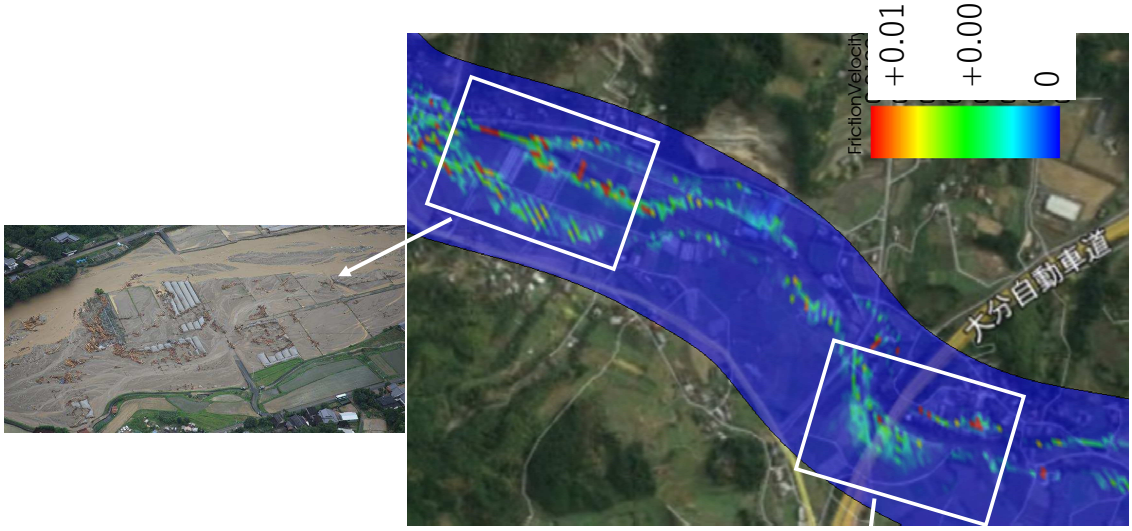


Driftwood volume involved in the flow body in unit area (m)
(Concentration ×Flow depth)

Driftwood volume deposited in unit of river bed (m)

(Yamazakli et.al 2018)

Depth averaged flow computed in case 4
(Movable bed with fine sediment- and driftwood-supply) (Harada, et.al 2018)



Computed results of driftwood distribution along the reach at the end of the flood

(Harada, et.al 2018)

Countermeasures to enhance regional resilience

Warning and evacuation system suitable for each unit region

Hazard maps based on new ideas; sediment and driftwood runoffs, flood flow with channel changes

Land uses according to hazard levels

Structure of the city by means of road system, drainage system, park, green belt, etc.

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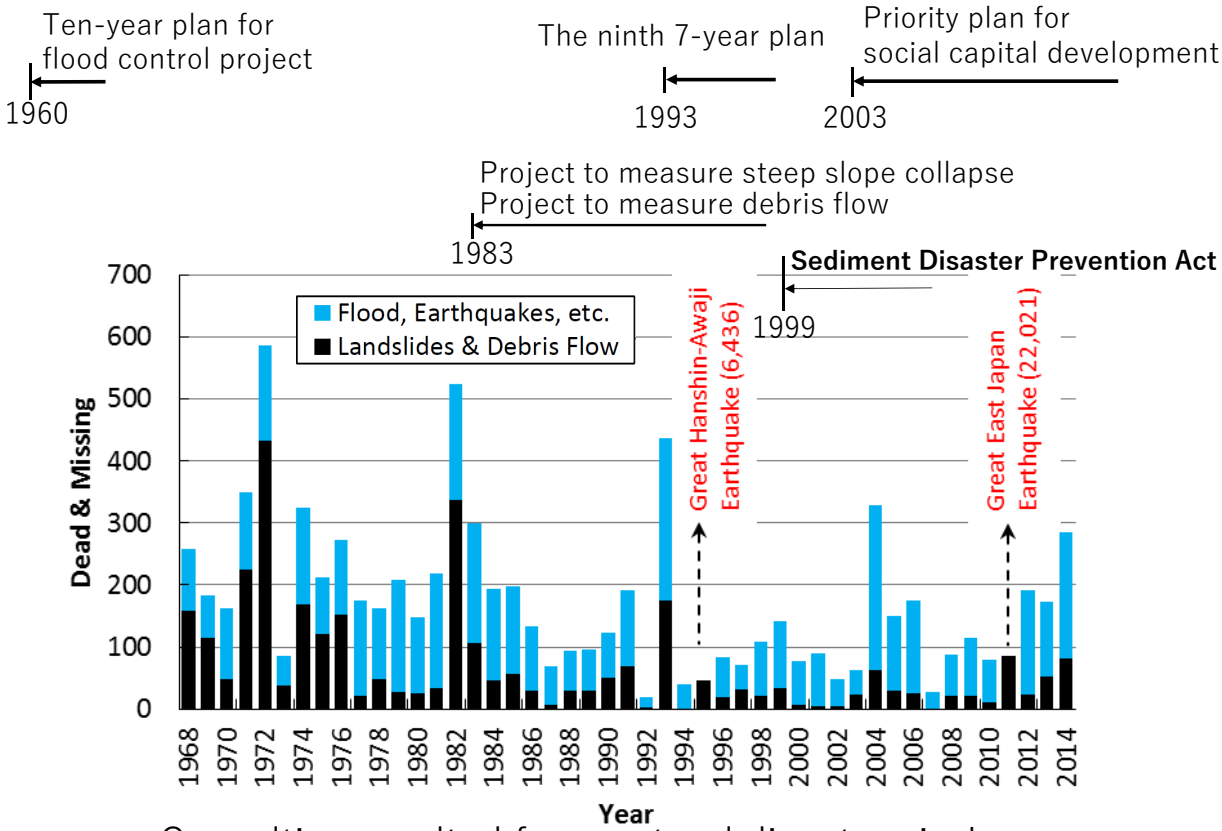
Development of sediment control structures based on recent debris flow study

e1



Casualties resulted from natural disasters in Japan

e1 egashira, 2017/11/25