

# Impact on Society of a Landslide and Emergency Response taken to Mitigate its Impact

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## Background of Research

Recently the frequency and intensity of storm events rate increasing. Together with increasing development activities, the landslide disasters have become more frequent. If roads, railways, or other infrastructure are damaged by a landslide, traffic is blocked, impacting regional social and economic life.

When such a disaster occurs, local authorities must promptly act to implement landslide countermeasures. Here it is important to care not only grasping landslide behavior but also the regional social and economic background of the area.

For future reference, we are presenting how Shizuoka Prefecture in Japan acted when a regional arterial road was damaged by a landslide in July 2007.



Fig.1 Landslide view from the sky (Photo by Shizuoka prefectural government; August 7, 2007)

## Damage minimization strategies

Emergency response was taken to mitigate landslide impact as shown in Table.1

Table.1 Timetable of events and response

Day	Time	Events	Response
Jul. 23	8:10	Cracks found on R136	9:00 Site survey (Prefectural authority went to check the cracks)
	10:00		One lane traffic closed
	15:30		Monitoring of crack expansion started
Jul. 24	17:30	Landslide displacement : 20mm/h	R136 entirely closed
	22:15		Newly designed extensometers were set (Fig.7)
	6:00	Landslide displacement : 50mm/h	
Jul. 25	18:00	Landslide displacement : 100mm/h	Emergency countermeasure works started (cut trees, removed unstable earth from the head part of landslide)
	6:00	The toe of the landslide grew downhill	
Jul. 26	6:00	Landslide displacement : 60mm/h	Experts visited the area to coordinate subsequent countermeasures
	18:00	Landslide displacement : 50mm/h	Slope protection works began (shotcrete, anchor, rockbolt)
Jul. 28		Landslide was still active	
Jul. 29			Temporary bridge started constructing
Jul. 30		Maximum displacement rate of 230mm/h	
Aug. 2		Landslide movement started slowly down	Shizuoka prefectural governor inspected the site
Aug. 6			Coring investigation and borehole inclinometer monitoring started
Aug. 9			First response meeting held
Aug. 11	12:00		One lane traffic opened after completing temporary bridge (Fig.8)
Aug. 23	8:00~10:45		R 136 temporarily closed due to rain
Sep. 6	7:50~16:45		R 136 temporarily closed due to rain
Mid Sept.		The upper part of landslide was confirmed to be stabilized	

## Points to see

- Newly designed extensometers enabling to measure long distance was installed.(Fig.7)
- Temporary bridge was built very fast to lessen the economic damage to the tourist industry caused by Route 136 closure.



Fig.7 Newly designed extensometer



Fig.8 Temporary bridge (Photo by Shizuoka prefectural government; August 7, 2007)

## The impact on tourist industry by landslide

Traffic volume of Route 136 : about 5,800 vehicles/day about 20,000 vehicles/day on the tourist season from July to August.

The impact on local economy caused by Route 136 closure for 19 days on the tourist season was investigated.

- Interview to local tourist industry
  - Hotel cancellation : about 2.5 times of previous year
  - Reservation of accommodation : compare with usual years
  - Profit : (Roadside restaurant, gas stations etc.) The damage was reduced after 11th August when the road was opened partly.

- Decrease of the number of hotel guests (estimated from spa tax that visitors have to pay for public authority) (Fig.9)

After landslide: about 20% from August to September about 30% from October to December

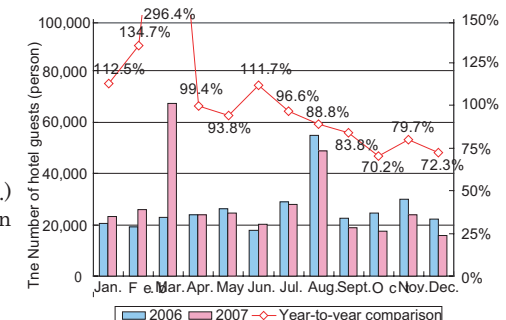


Fig.9 Monthly variation of the number of hotel guests (Data source; Toi hotel association)

## Rumor (e.g. the road is still closed) may have lasted long?

Because of the way of information of landslide to spread over public?

- Immediately after the landslide occurrence: the news of growing the landslide and Route 136 closure were reported as national headlines.
- However, the information of restoration such as repairing of the road was reported mostly in the local area.
- Should have been reported nationwide
- Shizuoka prefectural government : kept updating road information on their website.

## Conclusions

The authorities could minimize its impact on social and economical activities by taking prompt action. Also no casualty was reported.

It's necessary to provide up-to-date information people of not only when road was closed but also road was reopened to revive local economy.

## Overview of Toi Landslide

- Location : Toi, Izu city, Shizuoka prefecture, Japan (Fig.1, Fig.2)
- Geology and Geomorphology
  - Neogene Tuff and Quaternary Andesite lava
  - Convex slope (angle 25° ~ 30°)
- Size of the landslide : Length: 160m, Width: 40m  
Estimated volume: 28,000m<sup>3</sup>
- Occurred on July 23, 2007
- Landslide features
  - The landslide consists of four sub blocks. (Fig.4)
  - Maximum displacement rate: 230mm/h (Fig.5)
  - 60m in length on July 25
  - 160m in length in mid-September (Fig.6)
  - The upper part of landslide was stabilized following countermeasure application, but the lower part is still moving slowly.
- A part of Route 136 sunk (Fig.3)  
Road closure lasted 19 days (July 23~ August 11)

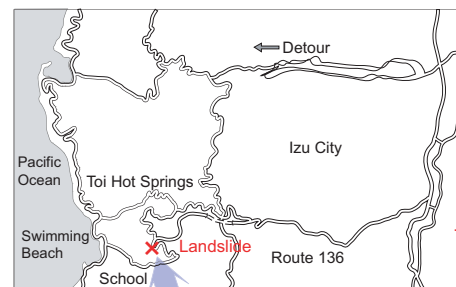


Fig.2 Location of Toi Landslide

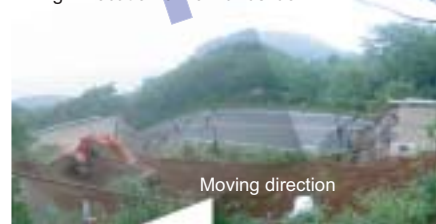


Fig.3 Collapse of Route136 (July 26, 2007)

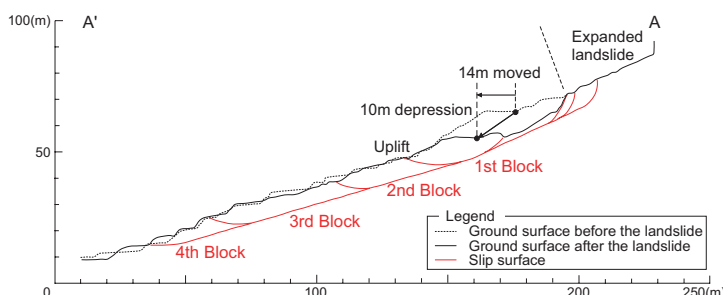


Fig.4 Cross section of Toi landslide

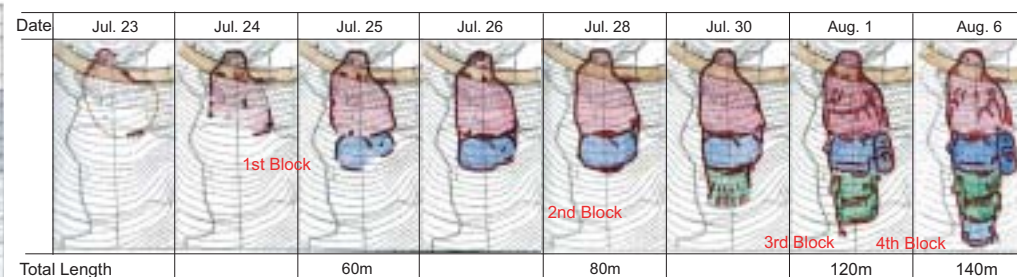
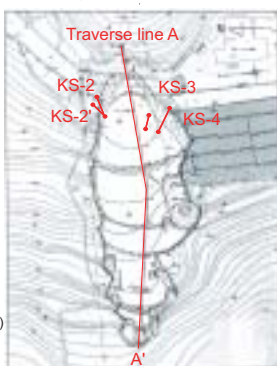


Fig.6 Sequence of landslide growth after July 23

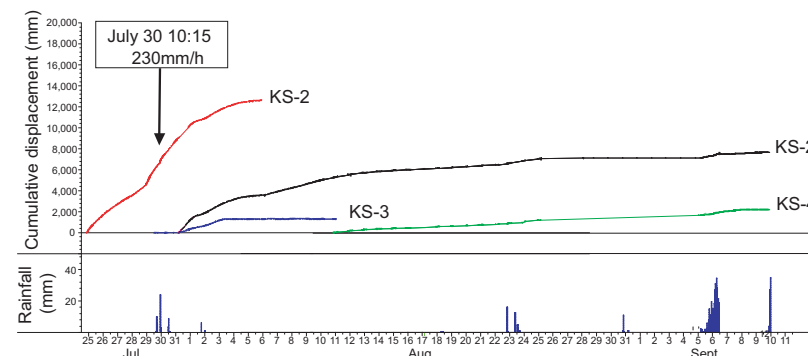


Fig.5 Landslide monitoring by four extensometers (See Fig.4 for the location)