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Lahar simulation using Laharz_py program for the Mt. Halla volcano, Jeju, Korea

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Lahar, one of catastrophic events, has the potential to cause the loss of life and damage to infrastructure over inhabited areas. This study using Laharz_py, was performed schematic prediction on the impact area of lahar hazards at the Mt. Halla volcano, Jeju island volcanic field. In order to comprehensively address the impact of lahar for the Mt. Halla, two distinct parameters, H/L ratio and lahar volume, were selected to influence variable for Laharz_py simulation.

Fig. 1. Location of Jeju Island, Republic of Korea

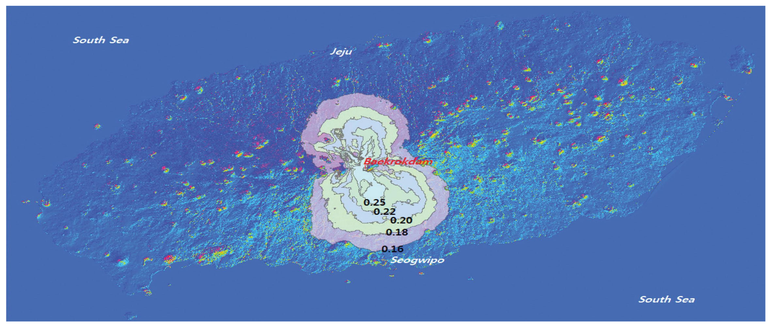

Fig. 3. Proximal hazard zone boundary with H/L ratio at Mt. Hallasan, Korea.

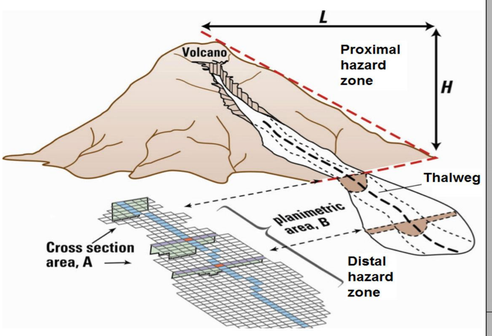

Fig. 2. Diagram showing association between dimensions of an idealized lahar and cross-sectional (A) and planimetric (B) areas calculated by Laharz_py for a hypothetical volcano (Schilling, 2014).
The ratio of vertical drop (H) to horizontal runout distance (L) describes the extent of proximal volcano hazards.
Laharz_py identifies cells where raster streams and the proximal-hazard zone boundary intersect as potential locations to begin calculations of distal lahar inundation hazard zones.

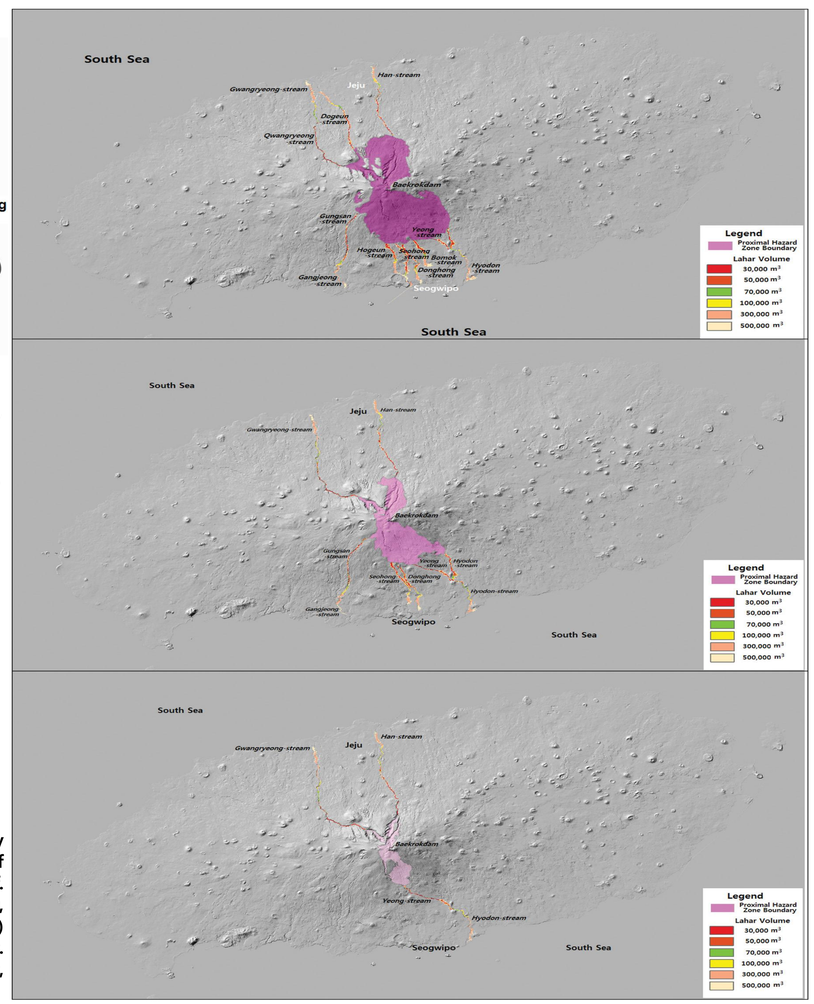

Fig. 4. Lahar-inundation hazard map constructed by applying Laharz_py to the Mt. Hallasan, Republic of Korea. Topography is depicted by shaded relief. The proximal hazard zone (Upper: H/L ratio=0.20, Middle: H/L ratio=0.22, Lower: H/L ratio=0.25) colored by the violet surrounding Mt. Hallasan(Baekrokdam) is subject to diverse hazards, including lahars.

Table 1. The travel distance of lahars can be reached by each stream generated by Mt. Hallasan according to H/L ratios and lahar volumes.

Stream	Lahar volume (m^3)	Travel Distance (m)						Remarks
		30,000	50,000	70,000	100,000	300,000	500,000	
H/L ratio = 0.20								
Gwangryeong		6,443	8,147	9,759	11,431	13,905	14,809	
Dogeun		4,686	6,157	6,978	7,861	9,772	10,112	
Han		5,826	7,869	8,668	9,551	11,091	11,152	
Gungsan		5,868	7,209	7,839	8,356	11,705	12,498	
Hogeun		2,006	2,566	2,770	3,130	4,695	6,670	
Seohong		4,252	4,733	5,201	5,747	7,437	-	join then reach the shore.
Donghong		4,058	4,435	4,694	5,380	6,335	6,672	reach the shore
Bomok		2,052	2,316	2,611	2,880	3,995	4,533	
Yeong		4,670	6,463	7,248	8,280	8,385	-	
Hyodon		2,784	3,317	4,170	5,323	8,895	-	join then reach the shore.
H/L ratio = 0.22								
Gwangryeong		6,446	8,410	9,735	11,682	14,974	15,838	
Han		6,082	8,195	9,611	10,648	12,465	12,568	
Gungsan		5,568	7,335	8,334	9,087	11,067	13,101	
Seohong		3,450	4,413	5,058	5,524	6,626	6,788	
Donghong		3,416	4,423	5,231	5,831	7,902	7,965	
Yeong		5,401	6,760	8,036	9,721	11,402	-	
Hyodon		3,571	3,778	4,243	4,960	9,645	10,199	join then reach the shore.
H/L ratio = 0.25								
Gwangryeong		5,878	8,015	9,422	11,356	15,646	16,375	
Han		6,438	8,081	9,571	11,415	13,405	13,668	
Yeong-Hyodon		5,838	7,185	8,125	9,585	12,857	-	join then reach the shore.

Table 2. Planimetric area(m^2) inundated by lahars with various volumes according to H/L ratios at the Mt. Hallasan.

Stream	Lahar volume (m^3)	Planimetric Area(m^2)					
		30,000	50,000	70,000	100,000	300,000	500,000
H/L ratio = 0.20							
Gwangryeong		193,300	271,800	340,300	431,100	899,200	1,260,300
Dogeun		193,100	271,600	340,600	430,900	899,500	1,260,200
Han		193,800	272,200	339,800	432,200	878,800	1,262,200
Gungsan		193,400	271,600	340,100	431,200	896,700	1,260,600
Hogeun		193,200	272,200	339,800	433,500	896,500	1,260,100
Seohong		193,200	273,000	341,900	433,900	897,900	1,263,600
Donghong		193,200	273,000	342,200	433,000	899,200	1,294,200
Bomok		194,200	271,700	339,900	432,100	897,900	1,264,500
Yeong		193,300	271,600	340,300	431,100	896,700	1,263,100
Hyodon		194,300	271,500	340,500	430,900	899,300	1,266,000
H/L ratio = 0.22							
Gwangryeong		193,300	271,600	340,500	430,900	899,400	1,263,500
Han		193,100	271,900	339,800	431,100	894,500	1,260,900
Gungsan		193,400	271,500	340,400	431,000	896,400	1,261,400
Seohong		193,300	271,900	340,500	430,900	896,500	1,260,100
Donghong		193,900	272,200	340,100	431,700	896,500	1,261,200
Yeong		194,300	271,500	340,100	431,000	899,300	1,269,300
Hyodon		193,600	272,200	340,400	430,900	901,200	1,265,100
H/L ratio = 0.25							
Gwangryeong		193,400	271,800	339,800	431,100	898,400	1,260,400
Han		194,000	272,000	339,800	431,200	897,500	1,261,100
Yeong-Hyodon		194,400	272,300	340,800	430,900	901,200	1,261,600

It was carried out on the basis of numerical simulation by estimating a possible lahar volumes of 30,000, 50,000, 70,000, 100,000, 300,000, 500,000 m^3 according to H/L ratios (0.20, 0.22 and 0.25) was applied.
Based on the numerical simulations, the area of the proximal hazard zone boundary is gradually decreased with increasing H/L ratio.
The number of streams which affected by lahar, tended to decrease with increasing H/L ratio. In the case of H/L ratio 0.20, three streams (Gwangryeong stream, Dogeun stream, Han stream) in the Jeju-si area and six streams (Gungsan stream, Hogeun stream, Seohong stream, Donghong stream, Bomok stream, Yeong stream-Hyodon stream) in the Seogwipo-si area are affected.
In the case of H/L ratio 0.22, two streams (Gwangryeong stream and Han stream) in the Jeju-si area and five streams (Gungsan stream, Seohong stream, Donghong stream, Bomok stream, Yeong stream-Hyodon stream) in the Seogwipo-si area are affected. And in the case of H/L ratio 0.25, two streams (Gwangryeong stream and Han stream) in the Jeju-si area and one stream (Yeong stream-Hyodon stream) in the Seogwipo-si area are affected.
The results of this study will be used as basic data to create a risk map for the direct damage that can be caused due to volcanic hazards arising from Mt. Halla.

Ministry of the Interior and Safety

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