Characteristics of sediment deposition distribution in debris flow disasters in caused by heavy rain in August 2014 Hiroshima, Japan

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1. Background
Post-war sediment disaster countermeasures have been promoted mainly by the development of structural measures. However, disaster prone areas are expanding annually owing to the development of residential areas. Owing to the difficulty involved in preventing sediment disasters by taking structural measures alone, nonstructural measures are being promoted. However, many of the victims of the sediment damage caused by the Heavy Rain Event of July 2018 were located in sediment disaster-prone areas. From these facts, we can see that the preliminary evacuation is inadequately performed.

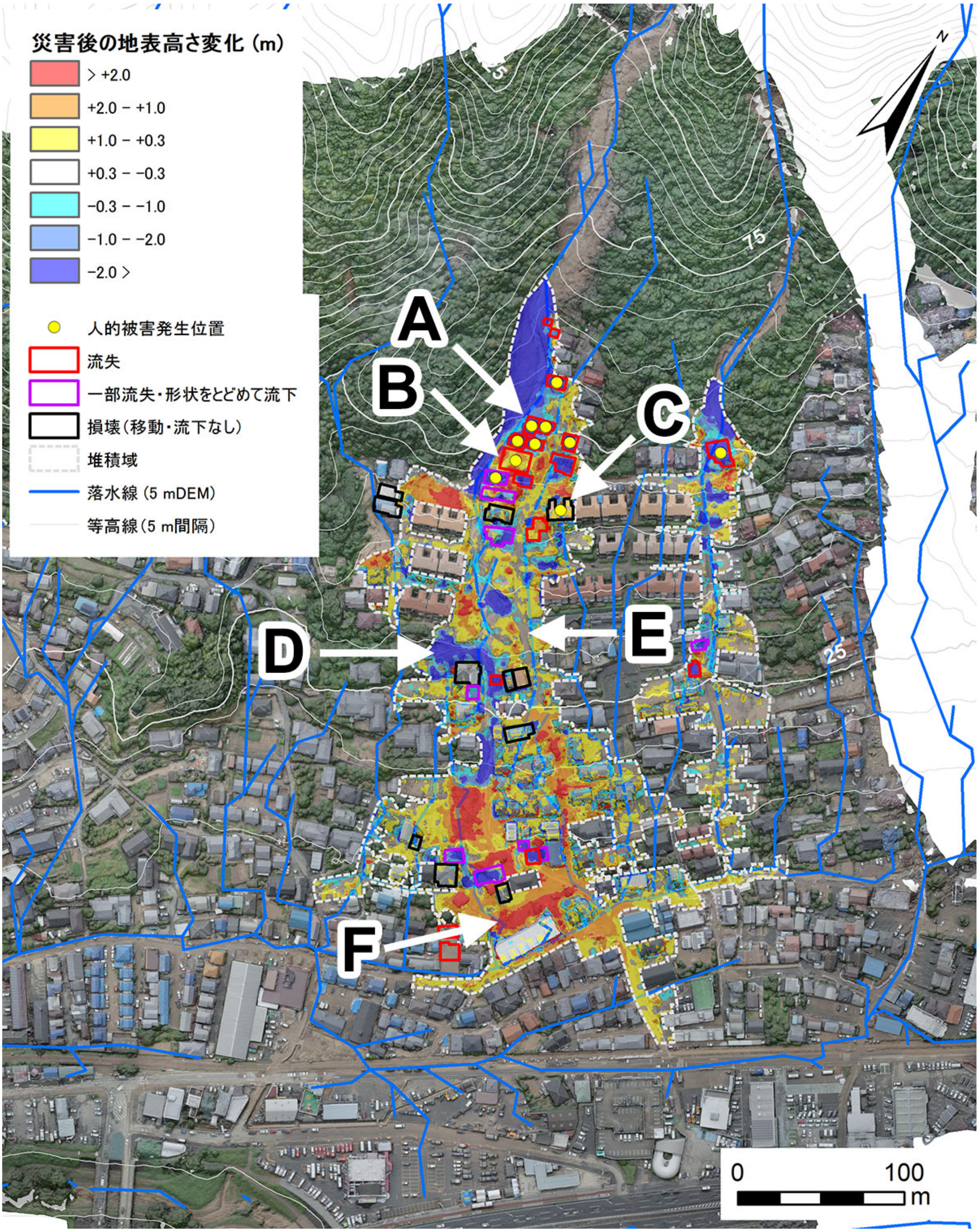
2. Purpose and significance
For autonomous evacuation to be conducted when the risk of the disaster is identified, it is necessary to anticipate the extent of damage possible in the inhabited areas. For example, the damage owing to debris flow can be predicted using knowledge of the behavior of debris flow and the relationship between debris flow and buildings or vegetation in the flow path. Therefore, in this study, the volume of sediment deposition by debris flow was measured, and its distribution characteristics were analyzed in six districts of Asaminami-ku, Hiroshima, which was damaged by the debris flow on August 20, 2014.

3. Method
There were 23 digital aerial photographs (Geospatial Information Authority of Japan) taken on May 21, 2008. Further, approximately four days after the disaster, unmanned aerial vehicles were used to capture aerial photographs, which comprised 700 vertical images. 30 points were measured by conducting a GNSS survey; 10 ground reference and 14 accuracy verification points were used. The spatial resolution of DSM and orthoimage created by SfM photogrammetry were 20.0 cm and 3.5 cm before and after the disaster, respectively. As a result of the accuracy verification of the DSM, the three-dimensional RMSEs at the accuracy verification point that employed 14 points were 26.2 cm (2008 DSM value) and 11.5 cm (2014 DSM value). The change in the height of the ground was obtained by subtracting the 2008 DSM elevation from the 2014 DSM value calculated using GIS. Next, the sediment deposition areas were interpreted from the orthoimage after the disaster, and polygon data were created using GIS.
In the surface height change data, a mesh having a positive value corresponds to sediment deposition inside the sediment deposition area polygon. At this time, we considered the error of the DSM at 2 periods as follows: the square root of the sum of the squares (28.6 cm) of RMSE values (26.2 cm before disaster, 11.5 cm after disaster) at each time were obtained as mentioned above, and only the mesh with a height change larger than this value was targeted.

4. Result
Of the results obtained, Yagi 3 districts were figured. There were two blue falling water lines near the center, and the main flow path widened to approximately 25 m. Within the range 70 m above and below the flow path, seven buildings were lost, resulting in 20 casualties (A). In the housing at the most downstream part of this row, a portion of the building moved downward while remaining intact, resulting in two casualties. In addition, the apartment that was in the center of this row of houses was lost in the debris flow; however, because it was a vacant lot in the pre-disaster aerial photograph, the apparent

change in the DSM appears to be sedimentary (B). In the public housing building located on the falling water line, sediment flowed, resulting in one casualty (C). Among the vegetation growing adjacent to the main flow path, the side close to the flow path was eroded (D). There was an area in which the sediment deposition thickness was in the main flow path thin (E). A sediment layer exceeding 2 m in thickness accumulated in the parking lot at the end of the main flow path. In the orthorectified images, the sediments exhibited a mud-like texture (F).

Keywords: debris flow, heavy rain in August 2014, volume of sediment deposition, UAV, SfM-MVS Photogrammetry


災害後の地表高さ変化 (m)
> +2.0
+2.0 − +1.0
+1.0 − +0.3
+0.3 − −0.3
−0.3 − −1.0
−1.0 − −2.0
−2.0 >
人的被害発生位置
流失
一部流失・形状をとどめて流下
損壊(移動・流下なし)
堆積域
落水線 (5 mDEM)
等高線(5 m間隔)
A
B
C
D
E
F
75
25
N
0
100
m