Temporal Response of NDVI in the Upper Reach of a River to Frequency of Lahar Occurrence after 2010 Eruption of Mt. Merapi

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INTRODUCTION

Even small amount of rainfalls, which does not trigger lahars before an eruption, can trigger them frequently if thick deposition of pyroclastic material such as volcanic ash covered the ground surface after the eruption. However, frequency of lahar occurrences will decrease with lapse of time, because rainfall-runoff process will change due to the recovery of permeability of the ground surface by erosion or re-growth of vegetation. For effective implementation of infrastructure restoration and emergency countermeasure against lahars after an eruption, it is essential to estimate temporal changes of risk of lahar occurrences. In this study, we focus on the percentage of the vegetation cover as a factor that affects the frequency of lahar occurrence. Temporal changes of NDVI (Normalized and Difference Vegetation Index) calculated using satellite images and frequency of lahar occurrences are compared in the river basins of Mt. Merapi, where lahars were frequently induced after 2010 eruption. Validity of NDVI for the index to estimate risk of lahar occurrence is discussed.

RESRARCH METHOD

Mt. Merapi is one of the most active of Indonesian volcanoes and erupted with pyroclastic flows since Oct. - Dec. in 2010. Pyroclastic flows traveled down along mainly Gendol River and thick pyroclastic material covered the ground surface. Most of volcanic ash produced by the eruption deposited in the southwestern flank of the mountain, centering Putih River basin. In the upper reach of both river basins, ground cover plants such as thatch were damaged by the deposition of pyroclastic material. Frequent Lahars were observed in the both rivers after the eruption. In this study, lahar occurrence frequency in the both rivers were evaluated based on articles of local newspapers (**Fig. 1**). 1 km spatial resolution MODIS (MODerate resolution Imaging Spectroradiometer) images, which cover both river basins, were downloaded from the website of NASA. Spatial distributions of NDVI were calculated with them (**Fig. 2**).

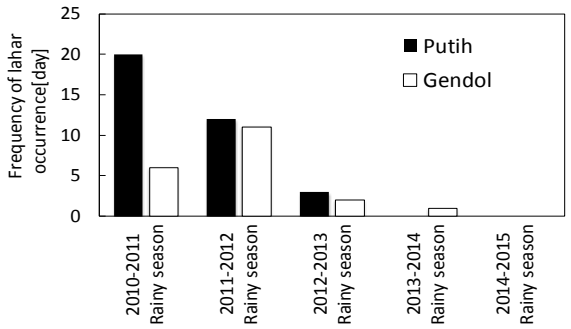

Fig. 1 Frequency of lahar occurrence evaluated based on local newspaper

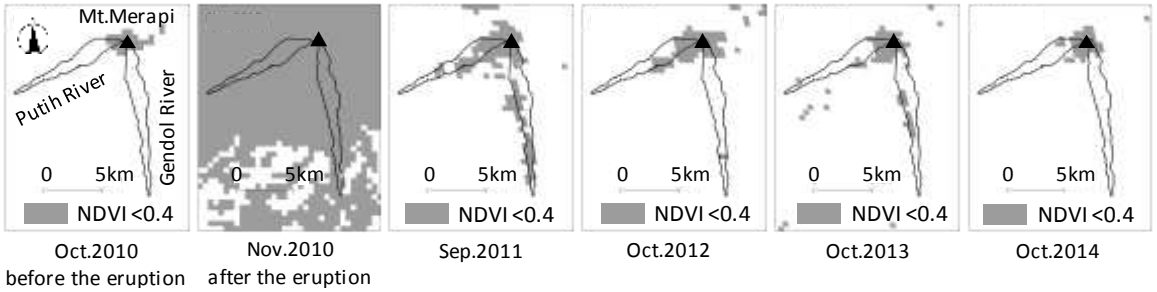

Fig. 2 Temporal change of NDVI since Oct. 2010 until Oct. 2014

RESULTS AND DISCUSSION

In the Putih River, the number of lahar occurrences decreased with lapse of rainy season (Oct. - Mar.) and no lahar occurred after 2013-2014 rainy season. In the Gendol River, the number of lahar occurrences increased in 2011-2012 rainy season. After 2011-2012 rainy season, it decreased with lapse of rainy season and no lahar occurred after 2014-2015 rainy season (**Fig. 1**). It is thought that the number of lahar occurrences increased in 2011-2012 rainy season is because of twice stream-captures between Gendol River and Opak River, which is an adjacent to Gendol River. Around Mt. Merapi, areas where NDVI < 0.4 corresponds bare land covered by pyroclastic material. In the upper reach of Putih River, percentage of area where NDVI < 0.4(PANL0.4), increased up to 100% in Nov. 2010, after the eruption. It decreased to approx. 30% in Sep. 2011 and decreased to approx. 10% at the beginning of 2013-2014 rainy season, which is as low as before the eruption in Oct. 2013 (**Fig. 3a**). In the upper reach of Gendol River, PANL0.4 increased up to approx. 50% in May 2011 and decreased to approx. 30% in Oct. 2011. It decreased to approx. 5%, which is less than before the eruption, in Oct. 2014, at the beginning of 2014-2015 rainy season (**Fig. 3b**). There is positive correlation between frequency of lahar occurrence and PANL0.4. PANL0.4 when lahar stopped occurring after the eruption is approx. 10% in the Putih River and approx. 5% in the Gendol River, which are as small as PANL0.4 of each river basin before the eruption. These results suggest PANL0.4 can be used as an index to estimate risk of lahar occurrences after an eruption.

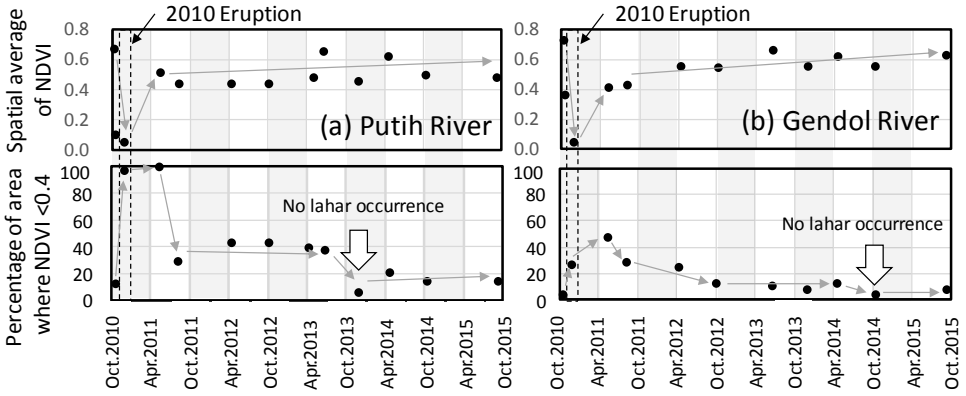

Fig. 3 Temporal change of NDVI in the upper reach of the Putih River (a) and Gendol River (b)

CONCLUSIONS

Results of this study suggest that risk of lahar occurrence can be estimated using NDVI evaluated using MODIS image. In order to show the universality of the results, further analyses at different volcanic area need to be conducted.

Keywords : Lahar, volcano, Mt. Merapi, NDVI, MODIS