

## Rainfall Thresholds for Sediment Related Disasters in Ambon City, Indonesia

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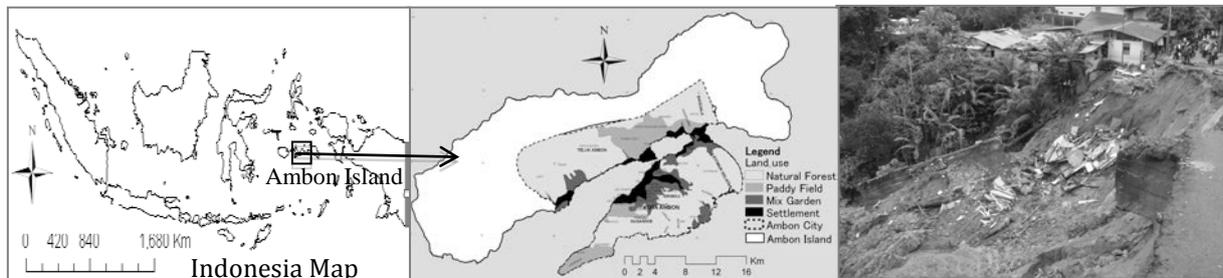
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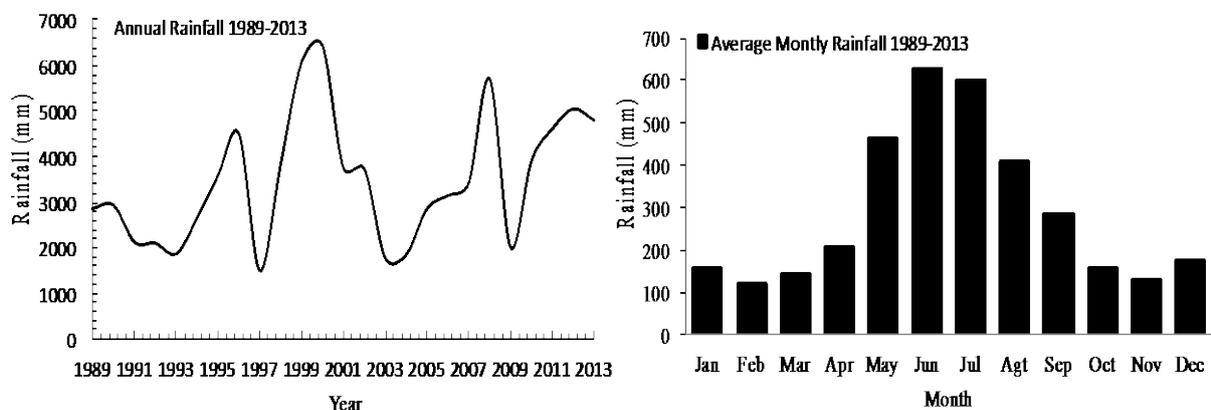
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### INTRODUCTION

Ambon is a city on the island of Ambon, Maluku Province, Indonesia, located at 3° – 4° South latitude and 128° – 129° East longitude. Regarding land use of Ambon city, 66.51 % of the land use is natural forest, 15.60 % is paddy field, 10.26 % is mix garden, and 7.63 % is settlement (**Fig. 1**). The area of Ambon city is about 337 km<sup>2</sup> with 73 % topographic conditions of slopes more than 20°. The geology is composed of volcanic rocks (69.02 %), coral (14.86 %), ultramafic rocks (6.46 %), alluvium (4.60 %), sandstone, shale, siltstone, with intercalations of conglomerate and limestone (4.42 %), and granite (0.64 %). In the last 5 years, the population is experiencing a high growth that reaches 7.49 % annually. The population is around 387,000 people. The area in Ambon city is relatively small and the high increase of population has been causing scarcity of habitable land, this situation force many citizens to build their houses in steep slopes with a high risk of sediment related disasters especially with strong intensity of rainfall. The average annual rainfall is about 3,481 mm/year (1989 to 2013) with high intensity rainfall occurring from May to August (**Fig. 2**).



**Fig.1** Location of the study area and sediment related disaster in Ambon city, occurred on July 15, 2012



**Fig. 2** Annual rainfall and average monthly rainfall from 1989 to 2013 in Ambon city, Indonesia

## OBJECTIVES

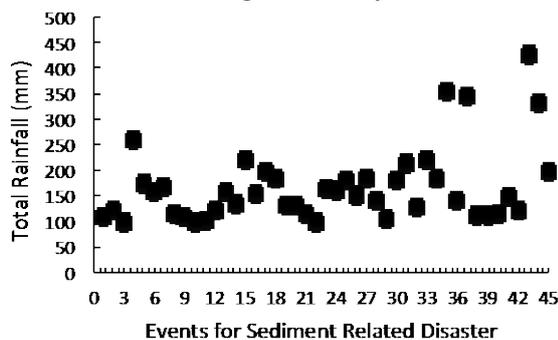
The objective of this study is to determine rainfall thresholds for possible sediment related disaster occurrence in Ambon city. The results of the study can be used for development of a warning system in the study area.

## METHODOLOGY

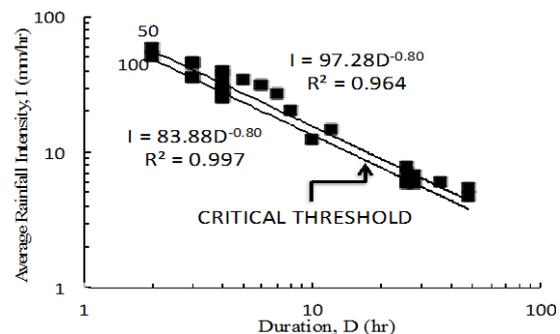
To determine rainfall thresholds for possible sediment related disaster occurrence in Ambon city, we first prepared a database of rainfall events that resulted in sediment related disasters from 2007 to 2013. Records of rainfall data and history of sediment related disasters were collected from the Meteorological, Climatological and Geophysics Agency and from the National Disaster Management Agency. The regression for rainfall thresholds is obtained from the relationship between the average rainfall intensity ( $I$ , mm/hr) and duration ( $D$ , hr).

## RESULTS AND DISCUSSION

The rainfall in Ambon city is very different from the rainfall conditions elsewhere in Indonesia, where generally the stronger rainfalls occur in December to March. Forty-five rainfall events resulted on more than two hundred sediment related disasters in Ambon city in the period from 2007 to 2013. Average amount of rainfall during all events with sediment related disaster occurrence was 171 mm with minimum rainfall of 101 mm (**Fig. 3**). There is not any report or information about sediment related disaster before 2007. However, it can be presumed that before 2007 many sediment disasters occurred. The regression value of rainfall thresholds for sediment related disaster (line [100]) was  $I = 83.88D^{-0.80}$ , where  $I$  is the average rainfall intensity in mm/hr and  $D$  is the duration of rainfall in hour (**Fig. 4**). This regression is considered as a reliable rainfall threshold for the study area, above which, sediment related disaster events may occur. In Ambon city the sediment related disasters occurred in short periods (2 hours) with high average intensity at least 51 mm/hr, and longer periods (48 hours) with a lower average intensity at least 5 mm/hr.



**Fig. 3** Rainfall events for sediment related disaster in Ambon city, 2007 to 2013.



**Fig. 4** Rainfall thresholds for sediment related disaster in Ambon city, 2007 to 2013.

## CONCLUSIONS

In Ambon city the sediment related disasters occurred in short periods (2 hours) with a high average intensity and longer periods (48 hours) with a lower average intensity. We determined new rainfall thresholds for possible sediment related disaster occurrence with the regression value of  $I = 83.88D^{-0.80}$ . We expect that the new rainfall thresholds can be used for development of a warning system in Ambon city.

**Keywords:** Sediment related disaster, rainfall threshold, warning system, Ambon city