Sand mining impacts on socio-economic inhabitant and river bed variation in Merapi Area

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1. INTRODUCTION

The Mount Merapi shown in **Fig.1** is one of the most active volcanoes of Indonesia. The volcanic materials are deposited at the slopes of the Mt. Merapi. The specific gravity of the deposited sediment is between 2.65 and 2.70 and the content of silt is 0.06% to 1.40%. Therefore, it has good quality for construction (Sutikno, 2003). Due to the increase in sand consumption, the total amount of the sand mining activity has been increased rapidly. Meanwhile, the lower Progo River which is a tributary originated at the Mt. Merapi has been affected by the material from its eruptions. In this paper, we discussed the sand mining effect on socio-economic condition and the river bed variation in lower Progo River.

2. SOCIO-ECONOMIC CONDITION

Based on data from Public Work Agency (2005), the population density in the Mt. Merapi ranges from 558 to 1045 persons/km^2 and the lowest is in Cangkringan. The average annual growth of population in the area ranges from 0.7 to 1.3%/year (DGWR, 2001b). The population growth of selected sub district in Sleman is shown in **Fig. 2**. The figure shows that the acceleration of population changes in mountainous area is larger than the others. Regional development provided by the Sabo work such as transportation access, irrigation or the sense of safety has encouraged people to use the land and other resources as well as the deposited sand in the area. Generally, inhabitants in Merapi area are farmer and husbandry as well as sand miner. The ratio of those small scale farmers amounts to 91% (DGWR, 2001b). The percentage of poor house holders in the sub districts in the area is from 17.5 % to 82.5%. This indicates that inhabitants have still low income. A questionnaire survey has been conducted in April to June 2008. The survey location consists of 6 sub districts, 9 villages and 31 sub villages. The numbers of respondent are 113, 45, and 122 in upper (rural), middle (urban), and lower area (rural), respectively. The results of the survey can be described as follows: a) the education background of inhabitants is low, b) most inhabitants have a second job to make the additional income, c) inhabitants in upper area have low income, d) inhabitants in upper area have an opinion that Mt. Merapi eruption provides resources, e) inhabitants in rural area still need the social facilities much more, f) sand mining activity is important for inhabitants in upper area and lower area, g) inhabitants use the rivers as sand resource, h) inhabitants recognize that river bed degradation occurred in upper and lower areas, i) 61,9% of inhabitants in upper area have an opinion that sabo works is useful. In the lower area, the percentage of inhabitants who have the same opinion is 80%.

3. THE EFFECT OF SAND MINING ON SOCIO-ECONOMIC CONDITION

Table 1 shows the effect of sand mining activity on socio-economic in the Mt. Merapi area. First, the activity has provided job opportunities for local people. They have earned opportunities as gravel collection and sales during the agricultural off season. The number of mining worker in foothills of the Mt. Merapi and the lower Progo River are 21,022 and 1,235 persons/day (Sutiarno, H., 2006), respectively. The daily income of sand miner is Rp. 6.000t to Rp. 36.000 (Aisyah, S., 2008). Second, the sand mining activity has also given an additional income tax for local government and the ratios of sand mining tax to total tax is 0.46% to 9.81%. The sand mining tax is important for Magelang district, but no so important for Klaten district. Third, if compare the tax per unit volume with regulation tax, it indicates that the tax per unit volume is very low. Therefore, the controlling and tax payment system of sand mining activity need to be improved.

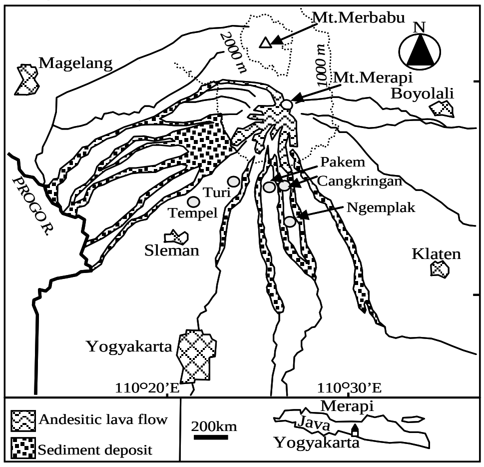

Fig.1 Circumstance surrounding the Mt. Merapi area

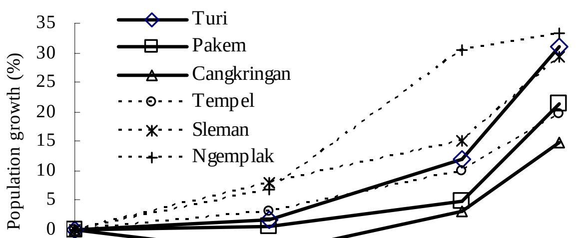

Fig.2 Population growth in Sleman District

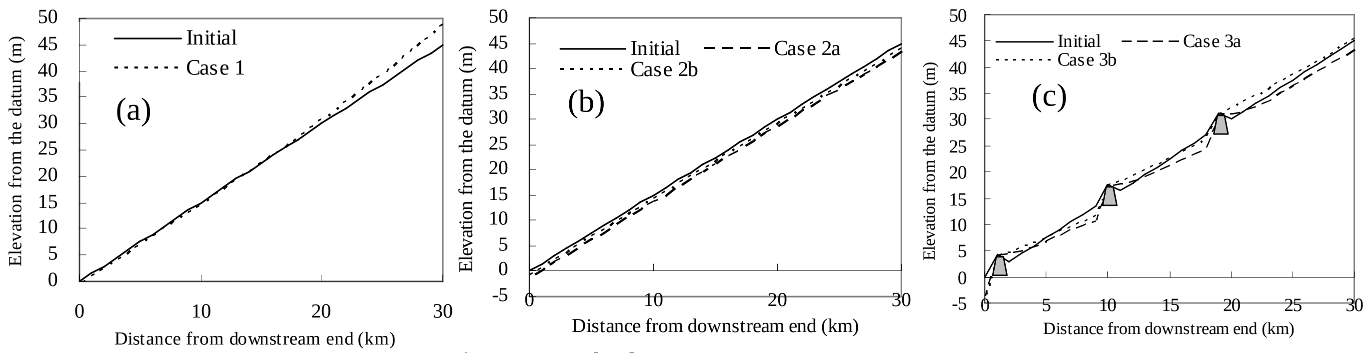

Fig. 3 River bed variation in 10 years

Table 1 Sand mining workers, annual sand mining volume and annual tax income

	Magelang	Sleman	Klaten
Employers/day	13,340	2,476	5,206
Sand mining vol. (m^3)	5,118,720	334,800	710,280
Annual tax (million Rp.)	8,847	10,696	6,216
Annual sand mining tax (million Rp.)	868	117	29
Tax ratio (%)	9.81	1.10	0.46
Tax per unit vol. (Rp./m^3)	169.57	349.46	40.83
Regulation tax (Rp./m^3)	575-775	405-525	1,750-3,250

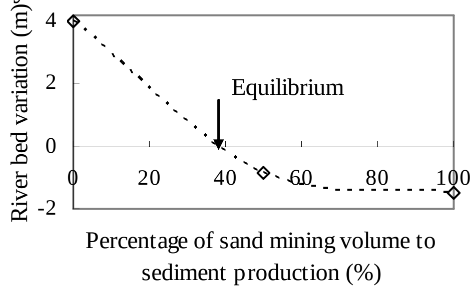

Fig. 4 Relationship between sand mining volume and river bed variation

4. THE EFFECT OF SAND MINING ON RIVER BED VARIATION

Recently, sand mining activities are very intensive; it means no sediment supply into the lower Progo River, resulting in bed degradation. To understand impacts of sand mining on the river bed variation, one dimensional bed deformation analysis is performed. The hydraulic condition is as follows; the annual average discharge is 83.1m^3/s, the average river width is 200 m, the initial slope is 0.0015 and the initial grain size of bed material is given referring to DGWR Report (2001a). In Case 1, the bed variation is simulated under a natural condition. It means a condition without management and sand mining. The result is shown in **Fig. 3(a).** Under this condition, river bed aggradation occurred. At the upper boundary, aggradation depth reached 4 m in 10 years. It indicates that a sediment management is needed. In Case 2, the sediment management by sand mining activity is considered. Cases 2a means the number of sand mining volume as same as sediment production volume. In Case 2b, sand mining volume is 50% of sediment production volume. The results under both conditions are shown in **Fig. 3(b).** Under both conditions, river bed degradation took place. In 10 years, degradation depth at upper boundary is estimated at 1.5 m and 0.8 m, for Cases 2a and 2b, respectively. **Fig. 4** shows relationship between the percentage of sand mining volume to sediment production and the river bed variation at the upper boundary. **Fig. 4** shows that the equilibrium condition at the upper boundary is kept if sand mining volume is around 39% of sediment production. However, due to the increase in sand consumption, it needs to take the sediment much more. Therefore, river bed degradation took place. In Case 3, river bed variation is simulated under the channel works installation and sand mining activity. The height of each groundsill is 2.7m and the longitudinal interval between groundsills is 9km. The result is shown in **Fig. 3(c).** If 100% of the sediment production is taken as sand mining, the bed degradation took places, even if groundsills are installed. The river bed slope in the upstream area was steeper, but the river bed slope at front of groundsills becomes milder. The phenomenon is caused by the effect of sediment mixture used in the simulation. As sand mining volume is 50% of the sediment production, the river bed degradation was protected by the installed groundsills.

5. CONCLUSION

The sand mining activities are important to support the socio-economic development of local people in the Mt. Merapi area as well as an additional income for local government. On the other hand, excess sand mining results in bed degradation. Therefore, combination of sand mining management and consolidation works is strongly required in the Merapi Area.

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