Impacts of Sediment Management on Socio-Economics and Environment in Mt. Merapi Area

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1. INTRODUCTION

Safety, river environment, and sediment utilization are the elements of the target of sediment management. The priority among three elements is depending on stakeholders. A change in an element by sediment management will affect the other two elements. Furthermore, the changes in the environment, safety, and utilization by a sediment management policy will cause the changes in the socio-economic condition. In this paper, the impacts of sediment management on the environmental and socio-economic aspects in Mt. Merapi area are discussed.

2. SEDIMENT MANAGEMENT AND ITS IMPACTS

If production is not too much sediment, the river basin is in stable condition. Even though under natural conditions, serious problem do not occur. However, if there is sand mining activity, the stability of the river basin will be disrupted. The activity will give negative impact from viewpoint of safety, such as bed degradation. On the other hand, if there is huge sediment production, under natural condition, sediment related disasters such as debris flows and bed aggradation would take place. In this situation, sand mining activity and sabo work are required in upstream area. However, it is very often that combination between sand mining and sabo works result in bed degradation in downstream area. Consolidation works is necessary to countermeasure the problem. The relationship between sediment management and its impacts on socio-economic condition is shown in **Figure 1**.

3. SCENARIOS OF PROPOSED SEDIMENT MANAGEMENT

The current issue of sediment related problem in Mt. Merapi area is the excess sediment yield from Mt. Merapi area, but there is also a riverbed degradation issue in the downstream of Progo River. On the other hand, sand mining activities in Mt. Merapi area are also extreme. Some scenarios for sediment management are set up as follows. A scenario under natural condition or without sediment management is assumed in Case 1. In Case 2, the sediment management by controlling sand mining activity is considered. Both the sediment management by the groundsill installation and sand mining regulation is performed in Case 3. The suffix “a” (ex. Case 2a and 3a) means the sand mining volume is equal to the annual sediment production ($1.44x10^6 m^3$/year). The suffix “b” (ex. Case 2b and 3b) shows the sand mining volume is equal to 50% of the annual sediment production ($0.72x10^6 m^3$/year).

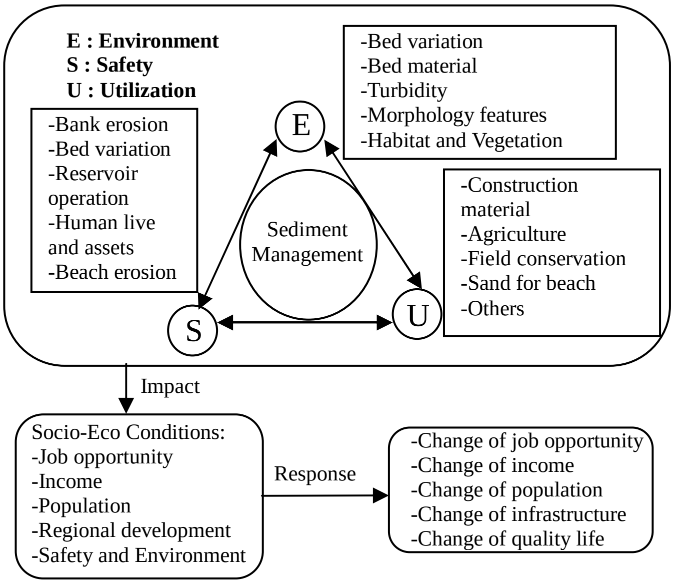


Fig.1 The relationship between sediment management and its impacts

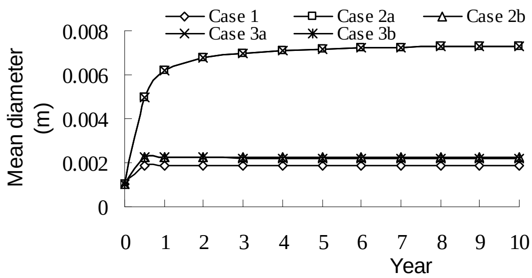
One dimensional bed deformation is used to simulate riverbed changes. The hydraulic conditions are set up as follows. The water discharge used here is the annual average discharge of $83.1m^3/s$, the river width is equal to the average river width of 200 m, the length of channel is 30 km, the initial bed slope is 0.0015 and the initial grain size distribution of bed material is determined referring to DGWR report, 2001. The mean diameter of the sediment is 1 mm.

4. RESULT AND CONCLUSION

(a) Effects on socio-economic conditions

The effects of sediment management on socio-economic conditions are evaluated by changes in job opportunity, additional income of inhabitants, sand mining tax of local governments, infrastructure development and so on. In this paper, changes in job opportunity and sand mining tax are used to evaluate the effects of sediment management on this aspect, as shown in **Figure 2(a**) If the sediment management under a current condition is maintained, it will provide great benefits in socio -economics. Local people have large opportunitiy to get job as sand miners and local governments get an additional tax. All the proposed sediment management will cause decreasing employment opportunity and declining additional revenue. Sediment management in Case 1 has the greatest negative impact. Cases 2a and 3a have the smallest impact, while Cases 2b and 3b have a medium impact.

(a) socio-economics



(b) the riverbed material

Fig.2 Effects of proposed sediment management

(b) Effects on environment

Sediment size is the one of the most important factor to affect on habitats for fauna and flora. Hence, the temporal change of the sediment size is discussed here. **Figure 2 (b)** shows size of the riverbed material changes at the upstream boundary for each case. Change of the riverbed material in Case 1 is not so big; the mean diameter changes from 1 mm to 2 mm. In the first year, the mean diameter of the riverbed material of Cases 2a and 3a changes from 1 mm to 7 mm. In Case 2b, the mean diameter of riverbed material changes fastly during the half first year, from 1 mm to 2.25 mm. Similar with Case 2b, in Case 3b the mean diameter of riverbed material changes from 1 mm to 2.22 mm.

(c) Effects on river facility structures

Effects of sediment management on river structures are calculated by estimating the risk of river structures. In this paper, a bridge structure, Kebon Agung I bridge with a pier height (*Hp*) of 11.75 m, a foundation depth (*Hf*) of 6.0 m (assumed), is used as a case study. For a bridge structure, the risk is discussed from the three parameters, namely P_1 (the risk of the foundation function), P_2 (the risk of the pier function) and P_3 (the risk of the bridge function). The value of riverbed variation (Δz) works negative if bed degradation occurs and positive if bed aggradation takes place. P_1, P_2 and P_3 are calculated by the following equations:

$$P_1 = \frac{\Delta z}{Hf} \quad (1)$$

$$P_2 = -\frac{\Delta z}{Hp} \quad (2)$$

$$P_3 = -\frac{H_w + \Delta z}{Hp} \quad (3)$$

Where H_W is the depth of water. Critical condition is achieved if the values of P_1, P_2 and P_3, are equal to -1. If P_1, P_2 and P_3 are greater than -1, it shows that the bridge is in a safe condition. **Figure 3** shows the effects of sediment management on the parameters P_1, P_2, and P_3. From the figure, we can see that the values of all parameters are greater than -1. It describes that no case gave a negative effect on the bridge structure. However, Cases 2a, 2b, and 3a require attention because of the risk of the foundation function tends to increase. The risks of the pier and the bridge functions have a tendency to enlarge in Cases 1 and 3b. However, changes in both parameters are not so fast. Hence, if the annual sediment production is considered, Case 3b is the most reliable of sediment management viewed from socio-economical, environmental and risk of river structure issues.

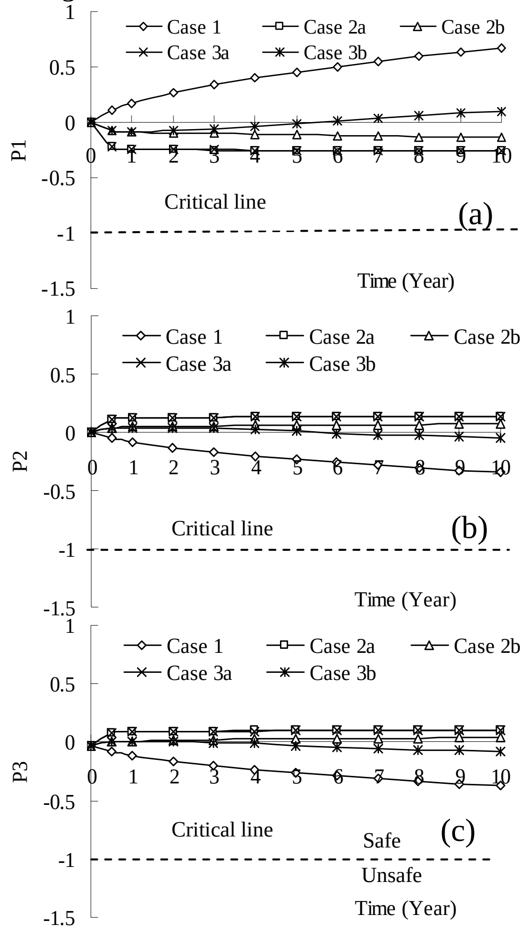


Fig.3 Effects of proposed sediment management on risk of bridge structure

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