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Current Research Abstract

Study of sediment hazard zone focusing on Kyoto, where several important cultural heritages are abundant along with spreading of urban areas towards hilly areas provides several important findings that could be helpful to mitigate sediment hazard in future.

It provides general introduction of trends of sediment hazard in Japan and approach to countermeasure against it from engineering prospective. In this regard the task is more difficult when urbanized areas need to be protected from sediment hazard where important cultural heritages are located.

One dimensional governing equations are helpful to derive debris flow and its conformation with similarity principles that is derived mathematically and proved numerically. In debris flow, particle motion is considered to be laminar flow, so it should follow Reynolds similarity. Contrarily, hydraulic model of debris flow is performed based on Froude similarity. Taking into account of apparent eddy viscosity Reynolds number of debris flow is discussed based on the momentum conservation equations and the constitutive equations, and numerical simulations are conducted to examine those characteristics. The results can be summarized as follows.

(1) Debris flow follows Reynolds similarity in the view of dynamics and at the same time, mathematically it can be seen that for debris flow the formation of

Reynolds similarity is same way as that of Froude similarity.

(2) The Reynolds number of a debris flow can be described as a function of Froude number. Mathematically, it is proved that debris flow follows both the similarities simultaneously. It means physical modeling could interpret the real debris flow occurrence when model is designed so that the topography is not distorted and the ratio of mass density of sediment to water/muddy-water is same.

(3) Numerical simulation of prototype and scaled models based on the condition as shown in (2) for sediment erosion and deposition conditions show that debris flow follow Froude similarity. The Courant number of the model also needs to be the same value to that of prototype in order to have Froude similarity.

In this research (study of debris flow and landslide) could help to mitigate sediment hazard is being discussed. Knowing occurrence condition of landslide or debris flow, which can be predicted abstractly by accumulated rainfall depth versus rainfall intensity graph, such movement of soil and water mixture is predicted by mass point system when hazard area is to be determined macroscopically and then set of governing equations corresponding to one or two dimensional flow models could be applicable for detail study of such disaster area. Studies related with dynamics of landslides and debris flow and how they can support design of countermeasures against sediment-induced disasters can be summarized as follows.

(1) The trend of counter measure against such sediment disaster in Japan is supported substantially by the associated research work.

(2) In order to predict sediment hazard zone, numerical simulation would be optimum tool that can evaluate the inherent flow characteristics caused by internal solid friction, rapid sediment erosion and deposition and then corresponding change of bed elevation.

Finally mass point system has been opted for delineating sediment hazard zone in Kyoto and Miyagawa is chosen for verifying the calculation of mass point system with field results. In order to answer why Kyoto is being chosen for studying sediment hazard area, hydrologic study and study of history of water induced disaster of Kyoto are done. It shows that Kyoto is susceptible for water induced disaster and casualties may occur whenever continuous rain fall exceeds 120 mm and that for Kyoto city is slightly greater. On the other hand, the meteorological data of Kyoto station of last 123 years shows that rainfall event of over the critical value (120 mm) happened to be several times in the past. Thus, water induced disaster may occur any time in Kyoto.

The hazard is more severe in Kyoto, because of the spreading of urban areas towards outskirts of the city near the steeper areas of hilly region. The hazard map shows that many such urban areas are under threat of sediment hazard where important cultural heritages are located as well. Therefore countermeasure keeping the cultural value of those areas is essential.

However, this study will help to recommend where people suppose to avoid living and how policy could be implemented to make such danger area isolated from public activities before it has been protected sufficiently to prevent any such disaster in future. While implementing structural method to protect the areas, the cultural value of the place needs to be intact and on the other hand non-structural countermeasures are primarily composed of warning systems and hazard maps, where the warning systems are intended to help evacuate people who live or travel in certain steep areas. Hazard maps describe the risk level of such dangerous areas, where such type of warning system could be implemented. However, there are certain public and private matters that may hamper to use warning system effectively. Thus, demand of new law that could support the implementation of such type of warning system is distinct in order to protect such hazard area effectively.