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Algorithm of Sediment Discharge by Debris Flow for Decision of Location and Scale of the Check Dam

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1. INTRODUCTION

In South Korea, most of the typical natural disasters are storm and flood in the summer season, and sediment-related disaster are causing human and property damage occurs every year in mountains. An effective methods to preventing damages of sediment-related disaster is the check dam. Therefore, it is necessary to predict sediment discharge from the catchment for maximize the effects of disaster prevention of check dam in planning. However, the location and size of the check dam is determined by empirical methods and civil complaints, without considering the watershed sediment discharge in the catchment. To overcome these limitations, many researchers have carried out studies on location and scale of check dam using statistical and physical techniques. But these studies are difficult to apply in the field, because they were performed in parallel. In this study, proposed an algorithm for predicting sediment discharge, which can reflect the topographical characteristics of catchment, and developed support system for determining of location and scale of the check dam.

2. PREDCTION OF GIS-BASED SEDIMENT DISCHARGE

2.1 Prediction eqauation of sediment discharge

Cumulative sediment discharge should be known according to stream length for optimal placement of the check dam. Because check dam is not always built at the downstream, and cumulative sediment discharge differs depending on the location. We used the relationship between stream length and sediment discharge according to stream width suggested by Seo et al.(2018)(Fig. 1, a). In the study by Seo et al.(2018), the most influential factor for sediment discharge were amount of slope failure on source area. It is due to repeated erosion and deposit in the stream. So in this study, the average stream width was calculated using the amount of slope failure on source area. First, the flow length was selected as a factor for predict the the amount of slope failure on source area. We analyzed the relationship between the flow length and slope failure on source area using spatial data of the 16 catchment collected in the previous study. We analyzed the the relationship between the slope failure on source area and stream width. As a result, the coefficient of determination showed a high value of 0.92(Fig. 1, b), so the amount of slope failure on source area can be used as a representative factor to predicting the stream width.

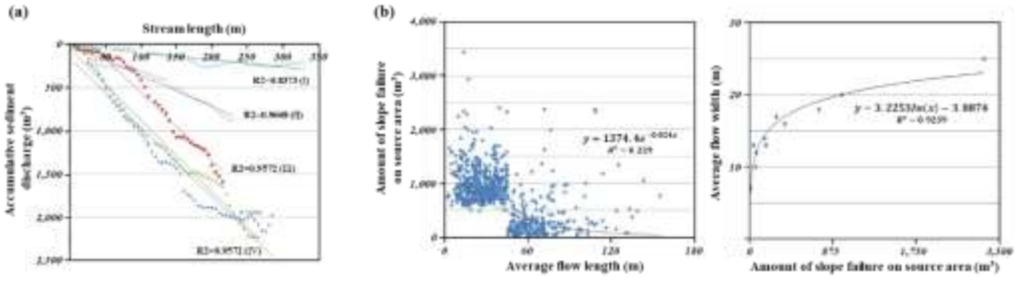

Fig. 1. The relationship between the stream length and accumulative sediment discharge by average stream width(a) the relationship between the flow length and amount of slope failure, stream width(b).

2.2 Prediction algorithm of sediment discharge

A prediction algorithm has been proposed to sediment discharge using prediction equations(Fig. 2). This algorithm is used for GIS-based spatial analysis program. The digital elevation model(DEM) is required as the input data of this algorithm. Digital elevation model uses assumed data through hydrological stream process of general GIS spatial analysis. The data is performed network analysis to estimate the length of the main stream from each tributary. At this time, calculate using each prediction equation is used to predict the amount of slope failure on source area and stream width(Fig, b). Sediment discharge is predicted using the prediction equation of sediment discharge according stream length by stream width(Fig. 1, a).

3. OPTIMAL LOCATION AND SCALE OF THE CHECK DAM

In this study, the sediment discharge prediction algorithm was divided into two methods, like as decision the scale of the check dam according to location, and decision the location of the check dam according to cumulative sediment discharge. First, the cumulative sediment discharge in the target catchment is predicted, and the location and scale of the check dam are decided according to sediment discharge. It was developed as a GIS-based program using the suggested prediction algorithm for sediment discharge and the method for optimal location and scale of the check dam. And this progeam was named ‘support system for decision of location and scale of the check dam’. The development environment of the program uses Microsoft's Visual Studio.Net 2005 and operated on ESRI's ArcMap 10.0 or higher version. The developed program is divided into four parts(sediment discharge model, analysis of sediment discharge in specific stream, analysis of sediment discharge in all stream, and decision on location of check dam (Fig. 4, b). Estimated sediment discharge is expressed in different colors depending on sediment discharge can be confirmed at the each stream, or final outlets). The location and scale of the check dam can be selected according to the estimated sediment discharge. If the user enters the desired volume of the check dam, the location of the check dam is selected according to the cumulative sediment discharge. In addition, the final outlets is shown together the total sediment discharge and reduced sediment discharge by the check dam. Based on this, it is possible to determine the systematic location and scale of the check dam.

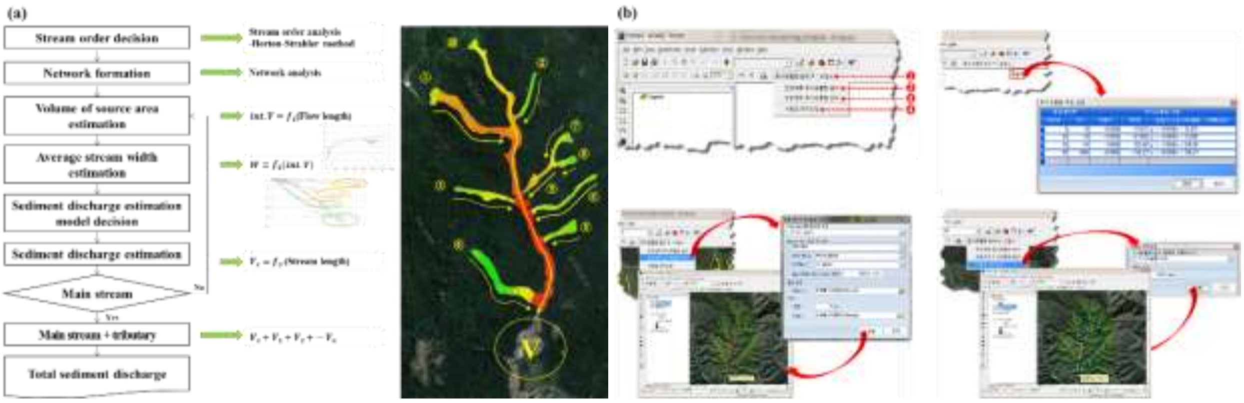

Fig. 2. Prediction algorithm of GIS-based sediment discharge by debris flow(a),
composition of program of support system for decision of location and scale of the check dam(b).