THE EVALUATION OF DRIFTWOOD IMPACT ON THE RIVERBANK

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ABSTRACT

Coarse woody debris (CWD) is a structural element of river systems which may enhance flooding frequency and damage infrastructure. The driftwood is often generated by landslide and river bank erosion. The large amount of driftwood may debouch into the reservoir or accumulate at bridges which can cause severe damage to the infrastructures. The removal of this driftwood requires much labor and cost.

The aim of this study is to develop a model to estimate the amount of driftwood in the watershed during the torrential rainfall. By using the technology of satellite image, landslide and hydrology analyses, this model is employed to estimate the amount of driftwood generated in Wu-Shih-Keng stream watershed and Hsueh-Shan-Keng stream watershed in the mid-Taiwan. It is shown that the model can reasonable estimate the amount of driftwood in those watersheds which can be applied to the future watershed management.

Keywords: Amount of driftwood, Coarse woody debris, Transportation distance, Watershed

INTRODUCTION

In recent year, intensive rainfall cause flood more frequently in Taiwan. Due to steep topography, vulnerable geology, and improper land-use, landslide and debris flow occurs frequently at the mountain areas of Taiwan where casualties and property losses from not expectable hazards especially during the typhoon seasons. The main reason is large logs from the slope land slide into channels referred to as coarse woody debris (CWD), and even cause drift woody disaster by the intensive rainfall during the torrential rain period. In the past research, main source of the drift woody is from thousands stere of the logs on the landslide.

The transport experiment showed that transport distance has a close relation to flow depth and also implied that the magnitude and sequence of a series of flows were important factors for S-CWD transport and retention in streams. According for the Log Transport Experiment and CWD Distribution Investigation result it can build the relation between representative water depth and transport distance.

The forces acting on CWD in streams are hydrodynamic(F) as in Eq.(1) and resistance (R) as in Eq.(2). where Cd is the drag coefficient of the log in water, ρ is the density of water, h is

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the water depth, θ is the angle of log relative to flow, U is the flow velocity, g is the gravity, σ is the density of the log, μ is the coefficient of friction between the log and the channel bed, α is the channel bed slope angle, and Asub is the submerged area of the log perpendicular to length.

$$F = \frac{1}{2} C_d \rho (lh \sin\theta + A_{sub} \cos\theta) U^2 \tag{1}$$

$$R = \left(g\sigma \frac{\pi l d^2}{4} - g\rho A_{sub} l \right) (\mu \cos\alpha - \sin\alpha) \tag{2}$$

The relation between the nondimensional water depth (h*) and the nondimensional force (Ψ) and transport regimes is as Fig.1. The threshold for movement of logs isΨ= 1, and the threshold for transport by floating is h_c^* as Fig.2. Assuming that the density of log is equivalent to the water, h_c^* is 1. Parameters were ρ = 1000 kg m-3, σ= 1000 kg m-3, k = 15, μ= 1.0, Cd = 0.8, CH = 70, α= 0.040 rad, and θ= 0.785 rad.

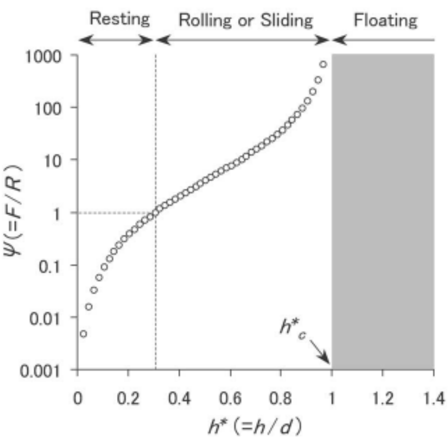

Fig. 1. The relationship between the nondimensional water depth h* and the nondimensional force (C) and transport regimes

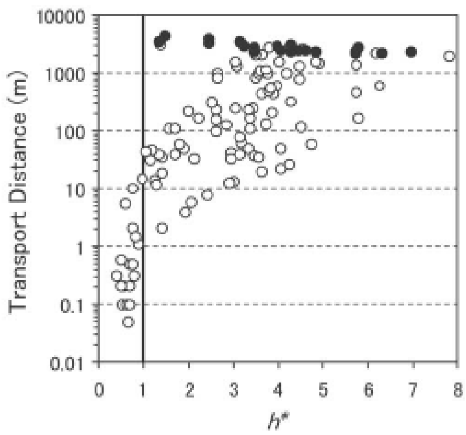

Fig. 2. the relationship between the nondimensional water depth h* and the transport distance

METHODS

Estimate the logs amount on the landslide

In this study, it according to the characteristics of forest type to understand the logs distribution in the river basin. And then extract out various kinds of forest type area in the river basin by Geographic Information System (GIS) technology. The areas of landslide are using the technology of satellite image to extract out.

Estimate the CWD amount on the landslide

In this study, it considers the rainfall event and the distance factor to determine the flowing-out amount of CWD. And assume the probability of flowing-out CWD amount on the landslide areas. Then it can use the probability of flowing-out to estimate the different conditions flowing-out rate.

The amount of CWD on the landslide is equal to Eq.(3)

$$\sum_{y=1}^{Y} CWD_{ny,Y}^{t} = \sum_{y=1}^{Y}\sum_{y=y}^{Y}\sum_{ny=1}^{Ny} W_{ny} \times \phi_{ny,y} \times \prod_{y=y}^{Y-1}(1-\phi_{ny,y}) \tag{3}$$

Where Y is Flowing-out the number of times; N_y is the y times areas of landslide; W_{ny} is the y times amount logs of landslide; $\phi_{ny,y}$ is the y times Flowing-out probability; $a_{ny,Y}$ is the Y times probability of exceeding

Hydrology analyses

In the experimental result of Haga, it can know some factors that are the flow of rivers and depth of rivers, etc to influence the driftwood transporting distance. So this study focuses on the watershed of main rivers hydrology analysis.
A).It is the first step to choose the representativeness rainfall.
B).And analyzes the Time of Concentration in the watershed.
C).Estimate the rainfall of Various Frequency-Year in the watershed.
D).Estimate the Peak Flow of Various Frequency-Year in the watershed.
E).Estimate the Depth of water of Various Frequency-Year in the watershed.

Estimate the amount of driftwood

In this study, it according to the research results of Haga to assume that the driftwood transporting distance is log-normal distributed. And use the Multinomial Maximum Likelihood Estimation to find the mean (μ) and the standard deviation (σ).Then it can get the probability of exceeding a drift distance.

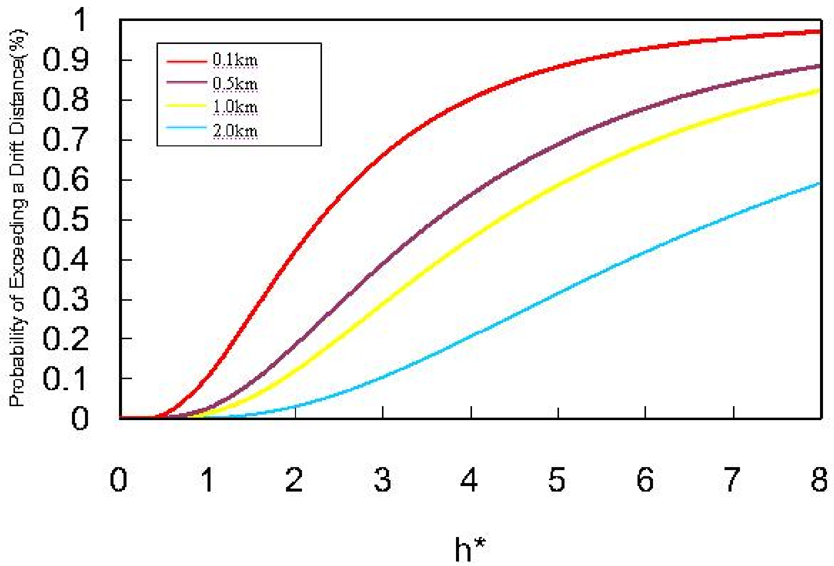

Fig.3. The relation between probability of exceeding a drift distance and the nondimensional water depth relation

1. Estimate the logs on the landslide

It is according to the Wu-Shih-Keng and Hsueh-Shan-Keng stream watershed logs distribution. In this case, it can divide wood into three kinds - subalpine coniferous forests, broadleaf forest and Mixed-stand. And use the Satellite image materials for three years to get the area of landslide.

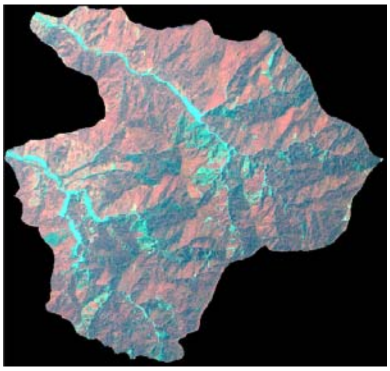

Fig. 4. 2005 the Wu-Shih-Keng and Hsueh-Shan-Keng Satellite image

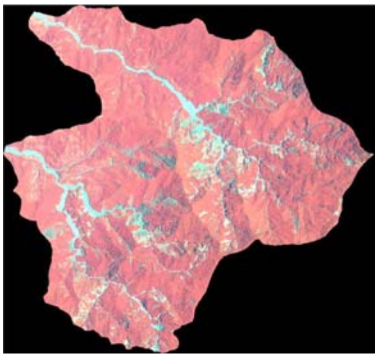

Fig. 5. 2006 the Wu-Shih-Keng and Hsueh-Shan-Keng Satellite image

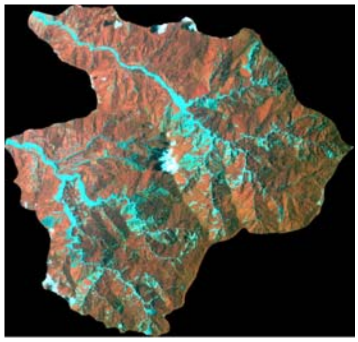

Fig. 6. 2007 the Wu-Shih-Keng and Hsueh-Shan-Keng Satellite image

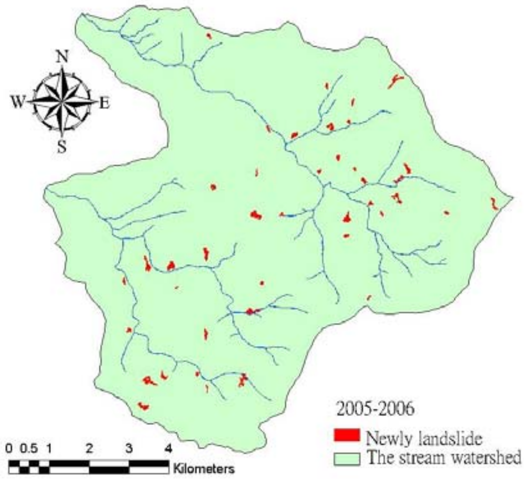

Fig. 7. 2005-2006 the area of landslide

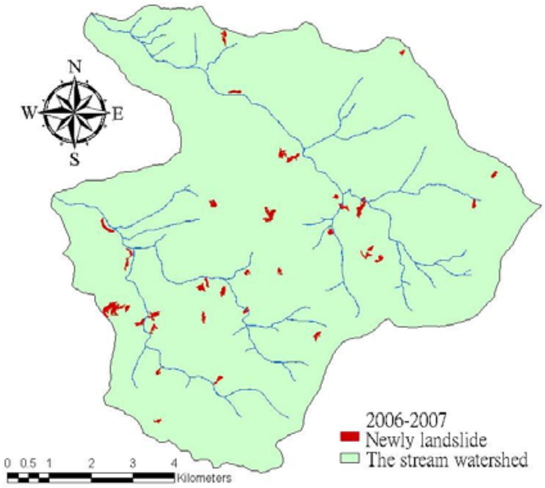

Fig. 8. 2006-2007 the area of landslide

2. Estimate the CWD amount on the landslide

According for this study assumed conditions, and using the GIS technology to Estimate the CWD amount and the flowing-out CWD amount on the landslide area.

Table 1. The Wu-Shih-Keng and Hsueh-Shan-Keng amount of CWD

Time	2005-2006	2006-2007
The CWD amount on the landslide area(m^3)	1126.63	6212.14
the flowing-out CWD amount (m^3)	5753.18	5210.38

3. Hydrology analyses

In this case, the river bank parameter is fixed. Using the Peak Flow and Manning Formula estimate the depth of water of various frequency-year in the watershed.

Table 2. The depth of water of various frequency-year in the watershed

various frequency-year	T=2	T=5	T=10	T=25	T=50	T=100	T=200
Hsueh-Shan-Keng (m)	0.80	1.01	1.14	1.31	1.44	1.58	1.68
Wu-Shih-Keng (m)	0.70	0.88	0.99	1.14	1.25	1.37	1.46

4. Estimate the amount of driftwood

According for this study assumed conditions, and fix the diameter of CWD. Then mark the every landslide in this two stream watershed as Fig 9. Fig10. And use the Eq(3) to calculate the amount of driftwood in the Wu-Shih-Keng and Hsueh-Shan-Keng stream watershed during the 2005~2007 as Table 3.

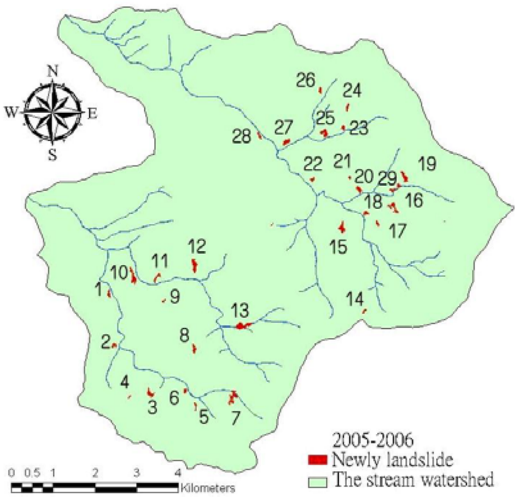

Fig. 9. 2005-2006 landslide number

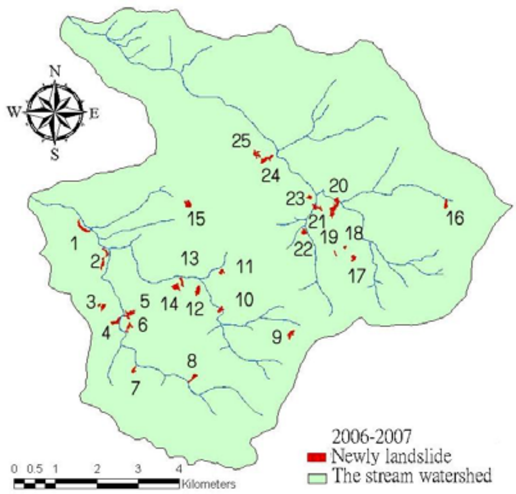

Fig. 10. 2006-2007 landslide number

Table 3. Estimate the amount of driftwood

Time(year)	2005-2006	2005-2007
Hsueh-Shan-Keng(m^3)	22.21	21.42
Wu-Shih-Keng (m^3)	0	237.08
Total (m^3)	22.21	258.50

CONCLUSION

The large amount of driftwood may debouch into the reservoir or accumulate at bridges which can cause severe damage to the infrastructures. By using the technology of satellite image, landslide and hydrology analyses, this model is employed to estimate the amount of driftwood generated in Wu-Shih-Keng stream watershed and Hsueh-Shan-Keng stream watershed in the mid-Taiwan. It is shown that the model can reasonable estimate the amount of driftwood in those watersheds which can be applied to the future watershed management.

There are many factors that need to do many experiments to find the relation. Confirm more parameters in the future that can be more perfect estimation the driftwood amount.

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