

# Ratio of rainfall driven erosion to runoff driven erosion for different understories on steep slope of forest

Afshin GHAHRAMANI<sup>1</sup>, Yoshiharu ISHIKAWA<sup>2</sup>,  
Katsushige SHIRAKI<sup>3</sup> and Takashi GOMI<sup>4</sup>

<sup>1</sup>Graduate School of Agricultural, Tokyo University of Agriculture and Technology, (3-5-8, Saiwai-cho, Fuchu-shi, Tokyo 183-8509, Japan, 50006539701@st.tust.ac.jp)

<sup>2</sup>Professor, Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology

<sup>3,4</sup>Associate Professor, Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology

We did field experiments in a steep forest hillslope to study on splashed soil by throughfall drops, washed soil by overland flow and ratio of splashed soil to washed soil for different understories. ratio of splashed soil to washed soil was 12%, 39% and 22% for very poor understory, moderate understory and very dens understory respectively, in all experimental plots soil movement by overland runoff was much important than movement by splashing.

In plot which had 2% understory, importance of washed soil was smallest but still there was large amount of splashed soil in comparing with the other plots, almost in all rainfall events amount of splashed soil from 2% understory was larger than all erosion (splashed + washed way) of the other plots which were possessing higher understory density.

**Key Words :** *erosion, splashed soil, washed soil, steep hillslope, understory*

## 1.Introduction:

Detachment of surface soil particles by the impact of raindrops is the first stage of erosion processes in a hill slope (Kinnell, 1990, Hudson, 1995). Soil particles detachment and transport by impacting rain drops is an important first step in soil erosion (A.I.J.M Van Dijk, at all 20003). Certainly there are complex interactions between rainfall-driven erosion process and soil and rainfall characteristics, slope gradient and soil treatment, these interactions so far are not well understood (A.I.J.M Van Dijk, at all 20003). Soil erosion Processes in a slope are mainly controlling by Rainfall kinetic energy and Surface Runoff shear stress (Römkens et al, 1985b). Physical understanding of the processes causing detachment and transport by falling rain drops has improved mainly by laboratory experiments (Ghadiri and Payne, 1986, 1988; Sharma and Gupta, 1989; Salles and Poesen, 2003).

Before creation of runoff Soil detachment is very important because unconcentrated runoff usually does not have enough power to actively detach and entrain soil particles (Rose, 1993).

Many researches confirm that soil detachment is a very important first step of erosion process in a hillslope, runoff depth that generated from ordinary rainfall may not have enough power to break down

cohesive force of soil particles and transport them if are not detached sufficiently. Most previous studies have focused on rainfall driven erosion or runoff driven erosion separately and mostly carried out on agricultural lands and not very steep slopes.

This study has been done in a real hill slope to clarify importance of soil detachment by rainfall comparing with overland runoff in steep forest hillslope for different understory densities.

## 2.Materials and methods:

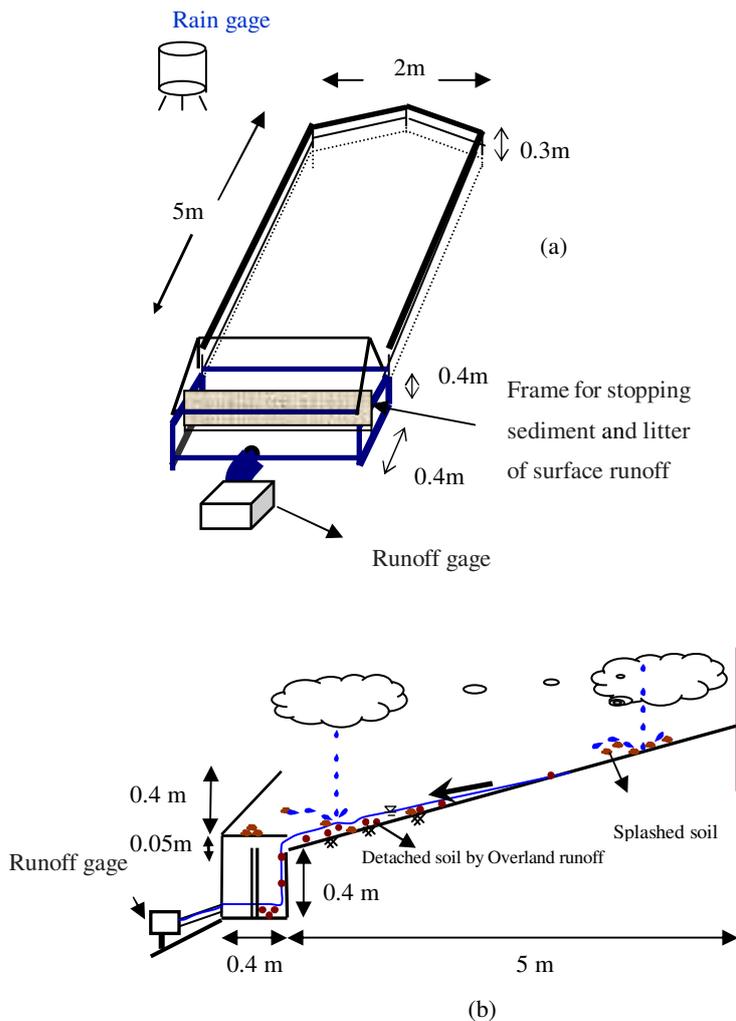
Experiments were conducted in Dodaira district of Kanagawa prefecture, Japan. Experiment site was located in a steep hill slope of a beech forest in Tanzawa Mountain, west of Yokuhama city and about 100 Km south west of Tokyo metropolitan.

3 plots with same size and different land covers were designed and installed. Splashed soil measured by boards in down and end part of plots, Board could trap all splashed soil particles which were splashing to out of plots toward down of hill slope.

For washed soil a sediment collector was installed to measure washed load. Figure (1) and table (1).

**Table 1** Experimental plots

Plot No.	Understory %	Slope	length m	width m
1	95	33	5	2
2	70	33	5	2
3	2	33	5	2



**Figure 1** Field experiment plots, (a)Schematic view of plot, (b)Cross section of of plot

Monitoring of erosion carried out from April 2007 to November 2007.

Annual rainfall of study area is 2200 mm, during our measurements 3 heavy rainfall events (typhoon) happened and these kind of heavy rainfalls that are usual for study site and in general happening during summer season.

The surface of hillslope soil has sandy loam texture with volcanic ash. Plots were located on a hillslope

and very close to each other. For choosing plots installation places it was considered to make in a conditions which canopy of trees and pattern of their leaf spatial distribution be almost same.

Plots with high and median understory were fenced, so animals like deer could not enter inside plots and their grass density were under control.

Runoff, rainfall and erosion data were monitoring (erosion weekly). Analysis of data carried out on weekly data.

Splashed soil and washed soil were collecting carefully then dried in oven and were weighted.

There are varieties of methods to measure soil detachment rate and transport by rain splash including splash cups, trays and boards. The results of experiments are affected by their geometry and can not translate into generally applicable parameters (Van Dijk, 2002)

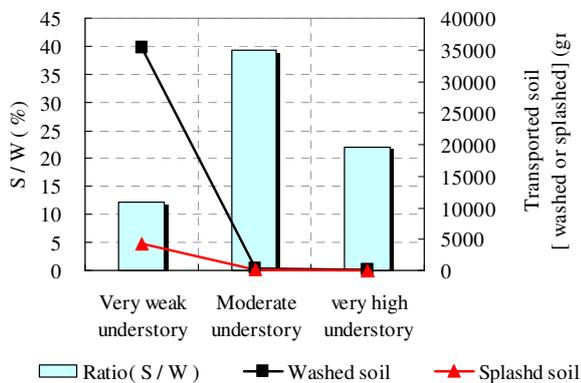
We used a new splash measurement method which could measure amount of transported soil by splashing. trapped soil in splash boards of our experimental plots were the final moved soil by splashing or re-splashing of soil particles

#### 4. Discussion:

With our measurement method we can discuss on affect and proportion of rainfall and runoff driven erosion in steep hill slope in all moved soil.

According to figure(2) amount of splashed soil comparing washed load in very poor understory was smallest than very high and 70% understory respectively, ratio in very poor vegetation condition was lowest but still amount of splashed was 100 times of very high understory density and 20 times of 70% density, because of large washed load its ratio becomes smallest. It shows that moving of soil by runoff is dominant transport mechanism for bare lands, but should notice that soil detachment by throughfall drops can be very important for making soil particles more ready to transport by runoff. High amount of splashed soil (comparing with the other plots) can confirm it. In very poor undedrstory movement by runoff is much important than movement by splashing of soil because soil surface can be detached freely by throughfall drops and runoff shear stress can act perfectly on surface soil particles and transport them, detachment by throughfall drops can be dominant detachment of particles but for movement phase washing by runoff is dominant than transport by splashing.

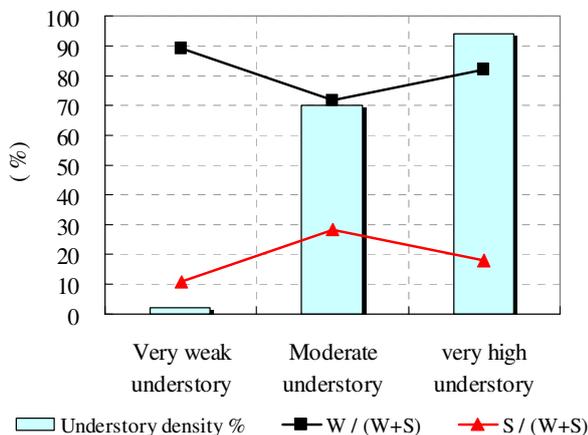
For 70% vegetation sediment movement by overland runoff was dominant, splashing was also important and 40 percent of total transport moved by splashing.



**Figure 2.** Ratio of splashed soil to washed soil  
S : Splashed soil, W : Washed soil

In figure (3) Contribution of splashed and washed soil for different understory density is illustrated. According to figure there is no systematic variation for contribution of splashed or washed soil in total erosion by increasing understory density.

In plot with 70% understory function of splashed soil is highest comparing the other plots and inversely function of washed soil is less than the other plots, but for all plots (any kind of understory) washed soil is dominant transport mechanism.



**Figure 3.** Contribution of splashed and washed soil to the all eroded

### 3. Results:

In all plots ratio of splashed soil to washed soil (S/W) is smaller than 1 and are 12%, 39% and 22% for plots with very weak, moderate and very high understory respectively. In all experimental plots soil movement

by overland runoff is higher than movement by raindrop energy.

The ratio of splashed soil to the washed soil of plots shows that there is not systematic variation between ratio of splashed soil to washed soil and understory density.

In a steep forest hillslope which has heavy rainfall events soil movement by overland runoff is much important than transport by splashing mechanism. washed soil is dominant soil transport mechanism.

There is no systematic variation between understory density and contribution of splashed or washed soil

### 5. Acknowledgments

We would like to appreciate to all members of SABO laboratory, Tokyo University of Agriculture and Technology for their help in field and collecting data.

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