Spatio-temporal Variation of Water Yield before and after Forest Thinning in the Yayama Experimental Catchment, Iizuka

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1. Introduction

Streamflow generation in headwater catchment is of great interests, and many studies have examined the streamflow generation mechanism of low-order catchmrents (Onda et al. 2006). Few studies showed the spatial differences of streamflow generation (Brown et al. 2005), however, did not consider seasonal variation.

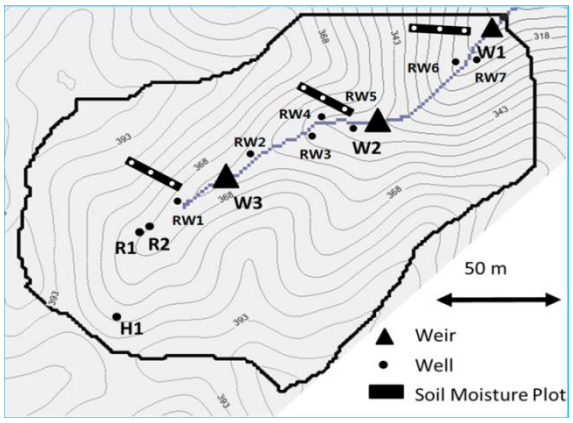

Figure 1 Study site and experimental design in Iizuka

Streamflow generation mechanism can be affected by the catchment vegetation together with the strong influence by topography and belowground environment. Forest management, such as thinning and clear-cut, can also induce the changes in water yield (Payn et al. 2012). Previous studies focused on the water yield changes at the outlet of the catchments due to the thinning or clear-cut, focusing on temporal variation. However, spatial variation in changes of the water yield pattern after forest management is yet to be examined.

In this study, we examined the changes in seasonal variation of spatial water yield pattern before and after thinning in a small headwater catchment that was underwent 50% thinning practice in January-March 2012. The changes in seasonal water yield patters were discussed using the factors controlling the change, such as groundwater and soil moisture.

2. Methods

The study catchment is located in Iizuka, Fukuoka Prefecture. The area of the catchment site is approximately 3ha underlain by granite. Runoff was monitored continuously at three points of the stream. Groundwater was monitored at both hillslope and riparian area: H1 (17.5m) is for hillslope groundwater. And R1 (20m), R2 (3.5m) along with RW1-7 (1-1.5m) are for riparian groundwater. Soil moisture was continuously monitored at three transects in the catchment. Each transect contains three sensor nests, and each nest contains three soil moisture sensors at the depth of 15, 35 and 55 cm.

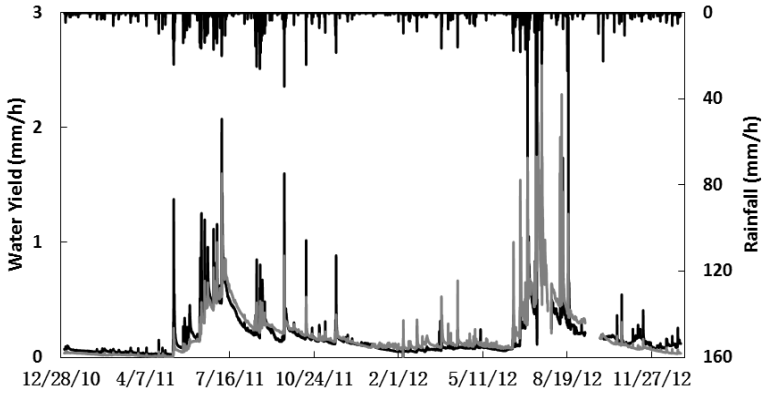

Figure 2 Hydrograph for upstream (grey) and downstream (black)

3. Results and Discussion

Before thinning during May to September in 2011, water yield calculated from the downstream gauge was greater than the one calculated at the upstream gauge. For the remaining of the year this trend was reversed (Figure 2). After thinning, the pattered reversed, and from January to September in 2012, the water yield from upstream gauge was greater than the downstream gauge (Figure 2).

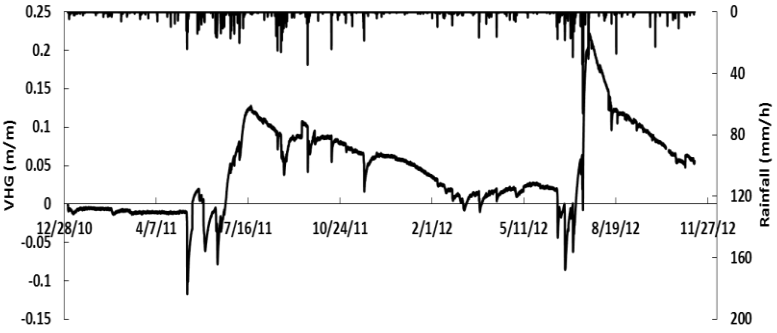

Figure 4 Vertical hydraulic gradient between R1 and R2, zero elevation is the valley floor

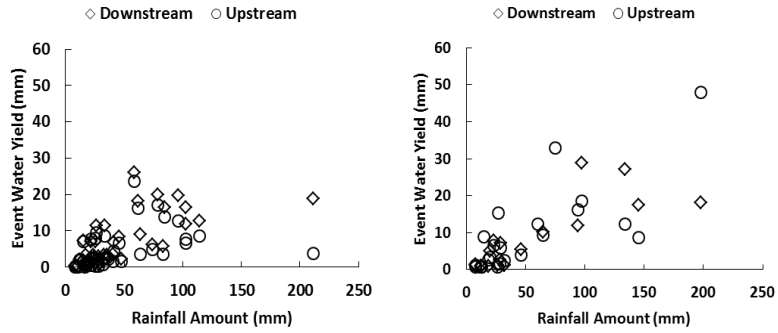

Figure 5 Event water yield against rainfall amount in 2011 (left) and 2012 (right)

Seasonal fluctuation of groundwater table differed before and after thinning. Hillslope groundwater table dropped below the valley floor during dry period before thinning. Though decrease in elevation also happened the same period after thinning, the hillslope groundwater table remained 1-2m above the valley floor. Vertical hydraulic gradient between R1 and R2 showed consistency with the variation in water yield pattern both before and after thinning (Figure 4). When the riparian groundwater showed downwelling trend (VHG<0), the upstream water yield was higher than downstream water yield. For the upwelling trend (VHG>0) in both years, it was consistent with the reversed water yield spatial pattern. Deep groundwater upwelling from upstream area can contribute to stream and cause the higher upstream water yield pattern.

Figure 5 showed the event water yield against rainfall amount before and after thinning. After thinning, both the upstream and downstream water yield increased. However for event water yield, downstream (0.34mm) didn't increase significantly as upstream (3.93mm). This can be explained by the shedding water characteristics of downstream and the understory vegetation effect in preventing overland flow.

References

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