

Article

# Influence of Rainfall on Canopy Interception in Mixed Broad-Leaved—Korean Pine Forest in Xiaoxing'an Mountains, Northeastern China

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**Abstract:** The mixed forest of broad-leaved and Korean pine is the dominant type in the Xiaoxing'an and Changbai Mountains of China. However, few studies have been done on its canopy interception of rainfall. In this study, rainfall amount, rainfall intensity, and canopy interception were monitored during the growing seasons in 2010 and 2011. The results showed that cumulative canopy interception of rainfall was 22.0% and 21.9% in 2010 and 2011, respectively. However, the canopy interception of rainfall varied with rainfall events from 6.6% to 82.7% in 2010, and from 8.7% to 80.2% in 2011. The relationship between rainfall amount and the ratio of canopy interception to rainfall amount could be described by a power function ( $P < 0.01$ ), i.e., the canopy interception decreased with the increasing rainfall amount and intensity. These results indicate that the rainfall amount and intensity were important factors for estimating the canopy interception of the studied forest type.

**Keywords:** rainfall amount; rainfall intensity; throughfall; stemflow; ecohydrology

## 1. Introduction

Forest canopy interception of rainfall plays an important role in the hydrological cycle and water resource management of forest ecosystems [1]. To identify the differences of canopy interception among different forest types, a number of studies have been finished in various regions [2–5]. The majority of rainfall interception studies have been conducted in forest ecosystems located in arid to tropical climates [6], with reported annual interception losses ranging from 10 to 50% of total precipitation [7]. And the ratio of canopy interception to rainfall amount for the major types of Chinese forest ranges from 14.7 to 31.8% [3].

The process of rainfall interception is normally dependent on the rainfall characteristics (e.g., rainfall amount, intensity, duration, drop size, and the number of raindrops), micrometeorological conditions, forest features such as tree species, the canopy structure (e.g., leaf area index (LAI), stem surface area, and crown gap fraction), and the antecedent weather [8]. Rainfall characteristics and forest canopy architecture have been recognized as the leading factors controlling the forest canopy interception of rainfall [1,9,10]. Therefore, most studies focus on one or more variables of the same group [11,12]. For example, some researchers reported that the rainfall amount was the most influential variable of forest canopy interception loss, followed by rainfall intensity [13]. Another study [14] suggests that the forest canopy rate of interception of rainfall increased proportionately with rainfall intensity when rainfall intensity was less than  $7.0 \text{ mm h}^{-1}$  and high-intensity rainfall events had lower interception values than low intensity rainfall events [9]. Under dry conditions, interception rates are primarily controlled by rainfall intensity [14]. Although rainfall characteristics were considered to be the most influential variables, the number of raindrops, raindrop diameter, and velocity were hardly included in the analyses of rainfall effects on canopy interception [15–17], except for in a study by

Zabret et al. [17], who reported that raindrops with a larger diameter (6.5–8.5 mm) and higher velocity ( $7.6\text{--}10.4\text{ ms}^{-1}$ ) reduced canopy interception of rainfall.

The mixed forest of broad-leaved and Korean pine (*Pinus koiensis* Siebold et Zuccarini) (the mixed forest, hereafter) is the dominant vegetation type in northeastern China, characterized by rich species and a complicated structure [18]. Many studies have been conducted on the ecohydrological processes of the mixed forest, such as rainfall partitioning (e.g., canopy interception, throughfall, and stemflow) [19,20] and the hydrological function (e.g., rainfall, canopy interception, evapotranspiration, and runoff) [21]. The rainfall-simulated experiment and Gash model were commonly used approaches to estimating the canopy interception of the mixed forest [22,23], but the simulated result was more proper for annual rainfall than for a single rainfall event. Therefore, the relationships between event-based rainfall amount, rainfall intensity, and canopy interception of the mixed forest type are still not clear.

Furthermore, the processes of rainfall interception, throughfall, and stemflow of forest canopy depend on the various properties of the rainfall characteristics [24], especially the rainfall amount and intensity [13]. The amount and intensity of rainfall vary in time and differ from event to event. The variability can substantially influence specific parts of the hydrological cycle, yet it is often not fully studied. On the other hand, the influence on rainfall partitioning is mainly analyzed from the forest ecology perspective, with little consideration of the characteristics of the rainfall (e.g., rainfall amount and intensity). Therefore, the main objectives of this study are, (i) to analyze the influence of rainfall amount and intensity on the canopy interception, and (ii) to analyze and evaluate this influence in a mixed forest of broad-leaves and Korean pine in Liangshui National Nature Reserve, China. Additionally, in the context of rainfall change caused by global climate change, this study is valuable in terms of regional hydrological data and models, especially in helping to understand how rainfall characteristics combined with forest types influence canopy interception dynamics.

## 2. Materials and Methods

### 2.1. Study Site

The study was conducted in a mixed forest of broad-leaved and Korean pine in the Liangshui National Reserve ( $47^{\circ}07'15''\text{--}47^{\circ}14'38''\text{ N}$ ,  $128^{\circ}48'08''\text{--}128^{\circ}55'46''\text{ E}$ ) in the Xiaoxing'an Mountains in northeastern China. The Korean pine was the dominant tree species in the forest, accounting for 63.7% of the woodland area and 77.4% of the total volume. The reserve covers an area of approximately 12,133 ha with elevation ranging from 280 to 707 m. The region has a temperate continental climate with cold and dry weather in winter and hot, rainy weather in summer. The mean annual temperature is  $-0.3\text{ }^{\circ}\text{C}$ , with 100–120 frost-free days and 130–150 days with snow cover. The mean annual precipitation is 676 mm (data from meteorological observation from 2000 to 2009 in the Liangshui National Reserve, about 1 km from the sample area), with the highest amount of precipitation in July (approximately 20% of annual precipitation).

The mixed forest of this study is unevenly age-tiered and is mainly composed of *P. koraiensis* and concomitant species such as *Betula costata* Trautv., *Tilia amurensis* Rupr., *Phellodendron amurense* Rupr., *Tilia mandshurica* Rupr. et Maxim., *Juglans mandshurica* Maxim., *Populus ussuriensis* Kom., *Acer mono* Maxim., and *Syringa reticulata* (Blume) H. Hara var. *amurensis* (Rupecht) P. S. Green & M. C. Chang. The understory shrubs and herbs grew luxuriantly in the mixed forest, dominated by *Acanthopanax senticosus* (Rupr. et Maxim.) Harms, *Corylus mandshurica* Maxim., *Aralia chinensis* Linn., *Philadelphus schrenkii* Rupr., *Euonymus verrucosus* Scop., and *Deutzia glabrata* Kom.

Based on the stock map of the Liangshui National Reserve, an area of  $0.2\text{ hm}^2$  ( $40\text{ m} \times 50\text{ m}$ ) of mixed broad-leaved and Korean pine forest area with minimal human disturbance was selected as a fixed observation or sample area. According to the survey, the selected forest was composed of *P. Koraiensis* and several associated broad-leaved species including *T. amurensis*, *T. mandshurica*, and *B. costata*; it is considered a typical mixed forest of *P. koraiensis* and *T. murensis* (Table 1). The average

diameter at breast height (DBH) of the selected forest is <20 cm, with a forest canopy cover of 70%, understory shrub coverage from 65% to ~85%, and herb coverage from 50% to ~85%. Most observations in the study were made based on the National Standards of the People's Republic of China for "Methodology for field long-term observation of forest ecosystem research" (GB/T 33027-2016) as follows.

**Table 1.** Forest conditions in the observation plot.

Tree Species	Total Number of Trees	Basal Area (m <sup>2</sup> ha <sup>-1</sup> )	Mean DBH ± SD (cm)	Mean Height ± SD (m)	Max Height (m)
<i>P. koraiensis</i>	241	22.7	39.8 ± 15.8	22.5 ± 5.8	32.0
<i>T. amurensis</i>	102	3.0	15.4 ± 12.0	14.2 ± 6.4	27.6
<i>T. mandshurica</i>	68	2.1	12.4 ± 10.0	12.5 ± 6.8	25.3
<i>B. costata</i>	61	2.1	12.2 ± 10.4	12.0 ± 5.4	24.0

## 2.2. Measurements of Precipitation (Rainfall), Throughfall, and Stemflow

The precipitation (*P*) was monitored during the growing seasons (May to September) in 2010 and 2011 with a tipping-bucket rain gauge (0.2 mm/tip) and a data logger (Model: JDZ02-1, Nanjing, China), which was extended above the forest canopy and mounted on an observation tower (45 m high and 50 m away from the sample area). When the adjacent rainfall interval time exceed 4 h, then it is divided into different rainfall events [13].

The throughfall (*Tf*) was collected and measured using five tilted gutters (180 cm × 20 cm) placed in the sample area randomly. The throughfall collector was set up not less than 50 cm above the forest floor to avoid understory and ground splash effects. Each collector was installed at an angle of 5° off level to facilitate drainage. The collector had 10 cm high risers on the four sides of the collector to reduce splash losses and its bottom corner on the low side was connected to a plastic tube which led to an automatic rain gauge (0.5 mm/tip) with a data logger (Model: JDZ05-1, Nanjing, China) for recording.

The stemflow (*Sf*) was collected using a halved rubber collar, which spirally wrapped around each selected tree stem. The selected trees were determined based on the DBH classes within the sample area. By measuring the DBH, all the trees were divided into six DBH classes ( $d \leq 20$  cm,  $20 < d \leq 30$  cm,  $30 < d \leq 40$  cm,  $40 < d \leq 50$  cm,  $50 < d \leq 60$  cm, and  $d > 60$  cm). Then five *P. koraiensis* trees with diameters of 28, 36, 42, 60, 78 cm and one *T. mandshurica* tree ( $d = 15$  cm) were selected as the monitored standard trees representing the mean growth of the six DBH classes in the studied forest. The stemflow was estimated with the obtained stemflow of a standard tree, the tree number of each diameter class, and the proportional area of each class within the studied plot (Equation (1)).

$$Sf = \sum_{n=1}^n \frac{S_i N_i}{A \cdot 10^4} \quad (1)$$

where *sf* is the stemflow volume (mm), *n* is the number of DBH classes, *S<sub>i</sub>* is the stemflow volume of the *i*th standard trunk (mL), *N<sub>i</sub>* is the number of trees for the selected DBH class, and *A* is the area of the studied plot (m<sup>2</sup>).

The forest canopy interception of rainfall (*I*) was estimated on a rain event basis using the wet-canopy water balance equation as follows:

$$I = P - Tf - Sf \quad (2)$$

## 2.3. Statistical Analysis

Due to a large number of rainfall events, regression analysis was conducted to describe the relationship between canopy interception and rainfall amount/intensity. The coefficient of

determination ( $R^2$ ) was used to assess the model fit. All the statistical analyses and plot displays were conducted using IBM SPSS Statistics 22 and Microsoft Excel, respectively.

### 3. Results

#### 3.1. Seasonal Pattern of Rainfall Amount and Intensity

During the growing season (May to September) of 2010 and 2011, 98 rainfall events were recorded with a total rainfall of 734.4 mm. The rainfall amount of a single rain event varied from 0.4 to 78.2 mm and there were more small rainfall events than large ones.

There was a great variation in rainfall intensity in both years from the minimum rainfall intensity of  $0.2 \text{ mm h}^{-1}$  to the maximum of  $20.6 \text{ mm h}^{-1}$ . The average rainfall intensity was  $1.8$  and  $1.6 \text{ mm h}^{-1}$  in 2010 and 2011, respectively. The less intense rainfalls (below  $3.0 \text{ mm h}^{-1}$ ) accounted for 89.0% of event numbers but only 68.3% of the total rainfall (Table 2). Rainfall events greater than  $5.0 \text{ mm h}^{-1}$  accounted for 6.5% and 3.9% of event numbers in 2010 and 2011, respectively, but for 30.9% and 9.3%, respectively, of the total rainfall amount.

**Table 2.** Rainfall characteristics during the growing seasons in 2010 and 2011.

Rainfall Intensity ( $\text{mm h}^{-1}$ )	Frequency (%)			Percentage Amount (%)		
	2010	2011	2010–2011	2010	2011	2010–2011
$\leq 1.0$	50.0	44.2	46.9	16.5	10.7	13.2
1.1–2.0	21.7	34.6	28.8	22.5	33.6	28.7
2.1–3.0	13.0	13.5	13.3	14.8	35.7	26.4
3.1–4.0	2.2	1.9	2.0	3.1	4.5	3.8
4.1–5.0	6.5	1.9	4.1	12.3	6.3	8.9
$> 5.0$	6.5	3.9	5.1	30.9	9.3	18.9

#### 3.2. Canopy Interception of Rainfall in a Mixed Broad-Leaved–Korean Pine Forest

The accumulative canopy interception was 161.4 mm, which accounted for 22.0% of the accumulative total precipitation during the growing season of both 2010 and 2011. In 2010, 71.6 mm (or 22.0%) of the total precipitation (325.2 mm) during the growing season was intercepted by the forest canopy, compared with 89.8 mm (22%) out of 409.2 mm in 2011 (Table 3).

**Table 3.** Summary of rainfall and interception loss in different years (factual observation data).

Summary Interval	Statistical Variable	2010			2011		
		P (mm)	I (mm)	I (%)	P (mm)	I (mm)	I (%)
Growing season	Total	325.2	71.6	22.0	409.2	89.8	21.9
Single Rainfall Event	Mean	7.1	1.8	34.4	7.9	2.0	34.2
	Minimum	0.4	0.1	6.6	0.4	0.1	6.7
	Maximum	78.2	20.5	82.7	30.8	8.1	80.2
	Standard deviation	11.7	3.2	27.8	8.8	2.0	25.9

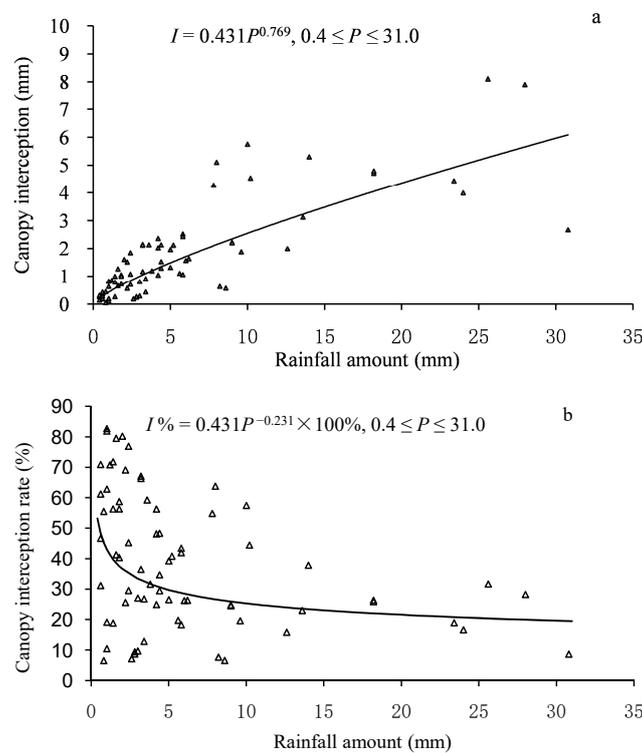
Event based rainfall analysis showed that the average event rainfalls were 7.1 mm and 7.9 mm, corresponding to rainfall interceptions of 1.8 mm and 2.0 mm, respectively, for 2010 and 2011, respectively. The interception ratio was 34.4% and 34.2% of rainfall in 2010 and 2011, respectively. However, both the maximum and minimum interception ratios of rainfall events occurred in 2010. The maximum interception ratio of 82.7% occurred for a rainfall event of 1.0 mm during 2 h with a rainfall intensity of  $0.5 \text{ mm h}^{-1}$  and a 76-h dry period before the rainfall. In contrast, the minimum interception ratio of 6.6% was observed for a rainfall event of 8.6 mm lasting for 1 h with a rainfall intensity of  $8.6 \text{ mm h}^{-1}$  and an antecedent dry period of 85 h.

### 3.3. Canopy Interception Variation with Rainfall Characteristics

Canopy interception was also influenced by rainfall intensity, rainfall duration, drying period of canopy before rainfall, and canopy evaporation. In this study, the highest precipitation was 78.2 mm, followed by 30.8 mm. As there were only limited data of the precipitation extreme, we chose the rainfall amount ranging from 0 to 31 mm to analyze the canopy interception in a broad-leaved and Korean pine forest (Figure 1a). The relationship between canopy interception and rainfall amount can be described by a power function ( $R^2 = 0.651, P < 0.01$ , Equation (3)).

$$I = f(P) = \begin{cases} P & (0 < P < 0.4) \\ 0.431P^{0.769} & (0.4 \leq P \leq 31.0) \end{cases} \quad (3)$$

where,  $I$  is the canopy interception of rainfall (mm) and  $P$  is precipitation (mm).



**Figure 1.** Relationship between canopy interception and rainfall amount: (a): amount of canopy interception, (b): canopy interception rate.

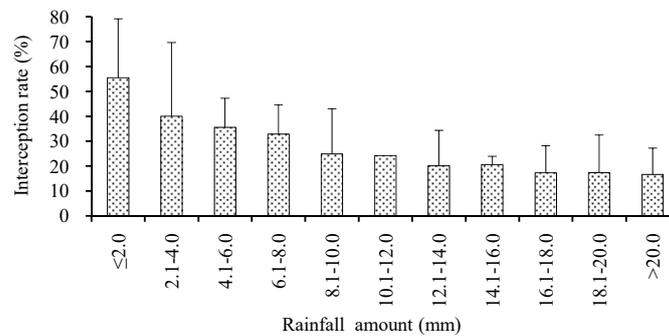
Canopy interception of rainfall is a dynamic process, thus the interception ratio is not a constant value. As shown in Figure 1b, the canopy interception ratio was the highest at the beginning of the rainfall, and decreased with precipitation, and then gradually decreased until reaching a constant value in the end. In this study, a canopy interception ratio ( $I\%$ ) model was developed based on the actual measurement of canopy interception by a mixed broad-leaved and Korean pine forest:

$$I\% = f(P)/P \times 100\% = \begin{cases} P & (0 < P < 0.4) \\ 0.431P^{0.769} & (0.4 \leq P \leq 31.0) \end{cases} \quad (4)$$

There was a significant difference between the forecasted and the actual canopy interception ratio. For example, in June 2011, there was a three-day consecutive rainfall event. The rainfall was 7.8, 3.8, and 1.4 mm and the canopy interception was 4.3, 1.2 and 0.3 mm, which accounted for 54.8%,

31.6% and 18.8% of the rainfall on the first, second and third day, respectively. But the forecast value of canopy interception was 26.8%, 31.7%, and 39.9%, respectively.

Measured data showed that canopy interception of rainfall varied with rainfall amount. The canopy interception ratio declined obviously with the increase of rainfall amount (Figure 2). When the rainfall was within 2.0 mm, the canopy interception was the maximum with a ratio of  $55.5 \pm 23.7\%$ , while when the rainfall was greater than 20.0 mm, the canopy interception was the minimum with a ratio of only  $16.7 \pm 10.6\%$ .



**Figure 2.** Variability of the percentage of canopy interception under different rainfall amounts.

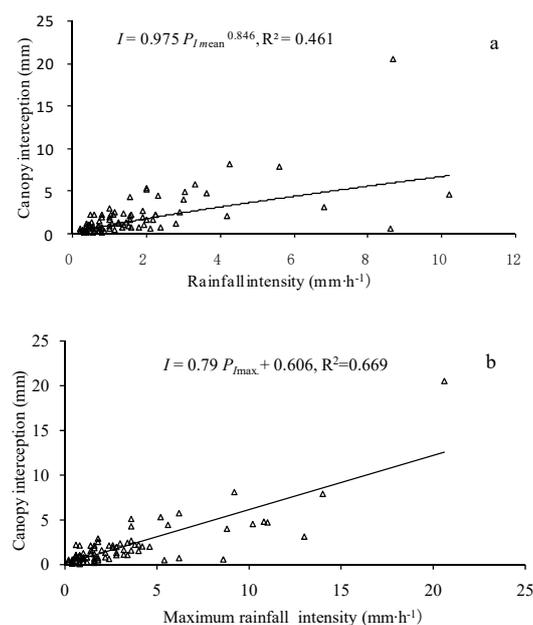
### 3.4. Influence of Rainfall Intensity on Canopy Interception

Canopy interception and average rainfall intensity were significantly correlated ( $P < 0.01$ ), which could be described by a power function (Figure 3a). However, a linear relationship between canopy interception and the maximum rainfall intensity can be fitted as follows:

$$I = 0.975 P_{I\text{mean}}^{0.846} \quad (R^2 = 0.461, P < 0.01)$$

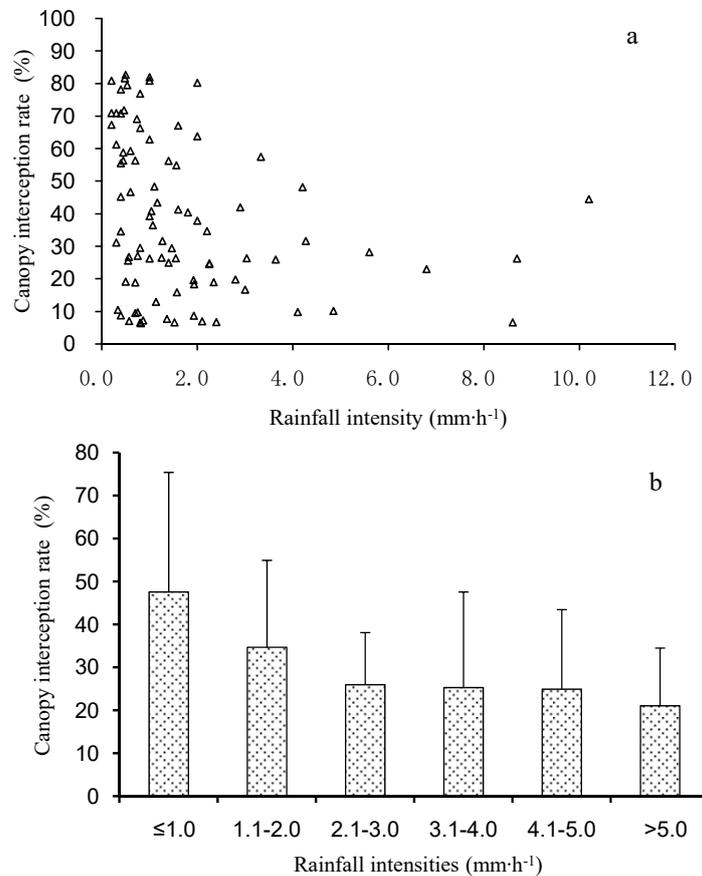
$$I = 0.79 P_{I\text{max}} + 0.606 \quad (R^2 = 0.669, P < 0.01)$$

where  $I$  is the canopy interception (mm),  $P_{I\text{mean}}$  is the mean rainfall intensity ( $\text{mm h}^{-1}$ ) calculated as gross rainfall amount divided by rainfall duration,  $P_{I\text{max}}$  is the maximum rainfall intensity ( $\text{mm h}^{-1}$ ) of a 60 min period within the rainfall event.



**Figure 3.** Relationship between canopy interception and rainfall intensity: (a): mean rainfall intensity, (b): maximum rainfall intensity.

With the increase in rainfall intensity, the canopy interception ratio was not discrete, and there was a reducing trend (Figure 4). Since only 11.2% of rainfall events occurred with rainfall intensity greater than  $3.0 \text{ mm h}^{-1}$ , whether the canopy interception ratio decreased with the increase of rainfall intensity needs further validation.



**Figure 4.** Variability of the percentage of canopy interception under different rainfall intensities: (a): mean rainfall intensity, (b): mean rainfall intensity classification.

## 4. Discussion

### 4.1. Canopy Interception by the Mixed Forest of Broad-Leaved and Korean Pine

The canopy of the mixed forest of broad-leaved and Korean pine intercepted about 22.0% and 21.94% of rainfall in 2010 and 2011, respectively. These results are within the range of 14.7–31.8% for major types of Chinese forests [3] and the range of 19.59–37.8% for the mixed forest of broad-leaved and Korean pine in other regions. However, the average canopy interception in this study was different from the average canopy interception ratio range of  $26.39 \pm 4.61\%$  to  $27.42 \pm 5.70\%$  in the Xiaoxing'an and Changbai Mountains [25–27] (Table 4). Other studies have also shown that the canopy interception of the mixed forest of broad-leaved and Korean pine in 2005 to 2007 was from 19% [20,28] to 22.00% [29], respectively. Another study carried out during 2010 and 2011 reported a canopy interception of 19.59% for the same type of mixed forest [28], which is very close to our results. These results indicate that the canopy interception of the mixed forest of broad-leaved and Korean pine is relatively consistent in its average rainfall-interception capability, but a greater variation exists for different rainfall events, from 6.6 to 82.7%.

**Table 4.** Rainfall redistribution characteristics of a mixed broad-leaved—Korean pine forest in different locations.

Location	Precipitation/mm	Time	Interception		Throughfall		Stemflow		References
			mm	%	mm	%	mm	%	
Changbai Mountain Range	599.1	May to Oct.—2005 to 2007	190.0	31.7	314.0	52.4	95.2	15.9	He et al. 2011
	743.1	Jan. to Dec.—1993	179.1	24.1	558.8	75.2	5.2	0.7	Liu et al. 1993
	469.2	Jun. to Sep.—2001	109.7	23.4	322.1	68.7	37.4	8.0	Xiao et al. 2002
Xiaoxing'an Mountains	763.7	Jan. to Dec.—1957	288.3	37.8					Wang and Zhang 1985
	648.2	Jan. to Dec.—1958	190.5	29.4					
	792.8	Jan. to Dec.—1962 to 1963	271.3	34.2					
	643.2	Jan. to Dec.—1963 to 1964	199.6	31.0					Zhu and Shi 1982
	712.2	Jan. to Dec.—1964 to 1965	195.2	27.4					
	716.0	Jan. to Dec.—1962 to 1965	222.0	31.0					Cai et al. 2006
	503.2	May to Oct.—2005	98.7	19.6	395.8	78.7	8.8	1.7	Ji and Cai 2015
	828.5	May to Sep.—2006	177.8	21.5	636.0	76.8	14.6	1.8	Zhang et al. 2012
	354.8	May to Sep.—2007							Chai et al. 2013
	354.8	Jun. to Aug.—2010	69.5	19.6	248.4	70.0	37.0	10.4	This study
514.1	Jul. to Oct.—2010	132.4	25.8	373.2	72.6	8.0	1.6		
325.2	May to Oct.—2011	71.6	22.0	252.6	77.7	1.0	0.3		
409.2	May to Sep.—2010	89.8	21.9	318.0	77.7	1.4	0.3		
409.2	May to Sep.—2011								

Note: In the Xiaoxing'an Mountains, the mean annual snowfall is 81 mm and the ratio of canopy interception to snowfall amount is about 21.2%.

#### 4.2. Effects of Rainfall Properties on Canopy Interception

A previous study suggests that rainfall properties are a greater factor than crown characteristics in the interception of shrubs [30], but the canopy structure is less important for rainfall interception predictions, as indicated by the reformulated Gash Analytical Model [31]. Rainfall amount is found to be the most influential and direct factor [13,32]. The power function models fitted in our study can well define the relationship of canopy interception with rainfall amount ( $0.4 \text{ mm} \leq P \leq 31.0 \text{ mm}$ ). This relationship differs from the linear correlation obtained in a study of shrubs [26]. The applications of different descriptive functions may be attributed to the differences in canopy and crown structure between the mixed forest in this study and the shrub in other study. As a rule, the canopy interception generally shows a rapidly increasing trend with rainfall amount before reaching its maximum canopy storage capacity, then slows down. Thus the exponential or logarithmic models were more used to fit the relationships between interception and rainfall amount than the power function model. Higher rainfall amount and intensity could reduce the percentage of rainfall interception [13]. In our study, with the increase of the rainfall amount, canopy interception ratio displayed a downward trend, in accordance with the studies of Sheng et al. [33] and Chen et al. [32] in Larch forests and Chinese pine forests.

Although a higher rainfall amount could result in greater canopy interception, the canopy interception would not increase continuously, but would stabilize after increasing to a certain degree. When the canopy interception was saturated, it could not increase any more with the increase in rainfall amount. The results in this study were consistent with Sun et al. [34], who studied the canopy interception of rainfall subalpine succession forest in Gongga Mountain and reported that the canopy interception increased with the rainfall amount and kept stable when it reached 1.27 mm.

Some previous studies also showed that rainfall interception loss was mostly influenced by rainfall intensity [13,32]. For example, Chen et al. [32] and Alan and Ali [35] reported that the canopy interception ratio was inversely proportional to the rainfall intensity. Kermavnar and Vilhar [36] found that seasonal variation in canopy interception was due to different rainfall intensities. However, Li et al. [37] and Peng et al. [38] found that the rainfall intensity had no significant effect on canopy interception. Some studies found that the canopy interception amount was significantly associated with the maximum rainfall intensity within the first 30 min rather than with the average rainfall intensity [39]. And several studies have reported that rainfall intensity did not have an evident impact on canopy interception in some forest types [36,40]. Therefore, whether there is an impact of rainfall intensity on canopy interception or not is still on debate. Our study showed that canopy interception had a linear relation to the maximum rainfall intensity ( $I = 0.79 P_{I_{\max}} + 0.606$ ,  $R^2 = 0.669$ ,  $P < 0.01$ ).

With the increase in rainfall intensity, the canopy interception ratio became less discrete, with a slightly decreased trend.

Additionally, in the context of global climate change, the influence factors of canopy interception are more complicated and varied. The factors of extreme weather (e.g., typhoons, rainstorms, hailstorms, freezing disasters, etc.) [41], human activities (e.g., forest management and forest planting) [42], and urban environments [6,36] can also have a strong impact on the canopy interception. Therefore, it would be more valuable if rainfall characteristics were integrated with other influence factors (e.g., canopy characteristics, meteorological characteristics, human activities, etc.) to qualify the canopy interception process.

## 5. Conclusions

Our study advances the understanding of interception processes in mixed broad-leaved—Korean pine forests and provides much needed data for the Xiaoxing'an Mountains. The findings underscored that canopy interception increased with the rainfall amount, while the canopy interception ratio declined. Furthermore, increased rainfall intensity seemed to have reduced the variation in the canopy interception ratio with an overall reducing trend. As the first attempt to evaluate the regional variations in canopy interception of rainfall in a mixed broad-leaved and Korean pine forest in the Xiaoxing'an Mountainous region, this study positively suggested that rainfall intensity was also an important factor in canopy interception in the mixed forest. This may help to understand how rainfall characteristics, combined with forest types, influence canopy interception dynamics.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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