Extreme Rainfall Induce Hydrological Environment Variation Assessment by Using IHA (Indicator of Hydrologic Alteration) in Taiwan

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INTRODUCTION

Serious natural disasters such as landslide, debris flow, flooding and sediment related disasters were induced by the Morakot typhoon on August 8, 2009 with rainfall amount of 2,900mm within continuous 3 days in Kao-Ping area. As a result, this research mainly concentrates on applying field investigations integrated with GPS/GIS/RS techniques which can be used to analyze and investigate the characteristics and mechanism of sediment related disasters. In order to decrease the risk of sediment related disasters, the strategy of soil and water conservation, hazard mitigation system and disaster control program should be proposed and executed as soon as possible. Hence, a study on the indicator of hydrologic alteration (IHA) influenced by this heavy rainfall event brought by Morakot become an important issue concerned by the government in Taiwan. This research was conducted by using HEC-RAS program developed from American Army Corps Engineering, USA. Also, Kao-ping watershed became a first priority to be selected as an important study area where was due to its seriously damaged by Morakot typhoon. The change of hydrological environment resulted from this extremely heavy rainfall during the past 10 years should be required as an important data for this study. All results indicate that the concentration of sediment for the Kao-ping watershed was increased 25~33% during the rainfall season and 5~8% increasing at dried season. Also, the period of drought season was significantly extended for almost 2 moths and the frequencies of heavy rainfall amount rapidly increase in Kao-ping watershed located at the southern part of Taiwan.

IHA ANALYSIS

Kaoping watershed was greatly affected by the un-even distribution and intensive concentration of rainfall amount and intensity as well as by the conditions in the surrounding environment. Consequently, the validity of result analyses depends on the ability of investigator who can give a true picture of the precipitation data and discharge information during the period of heavy rainfall within watershed in relation to the geologic properties of rocks and soils weathering from limestone and mudstone. The initial stresses present in the ground are also important as well as the hydro-geological condition. However, each of these factors combing with hydrological environment conditions is a function of complex interrelations between each other. **Tab. 1** shows the variation of IHA (Indicator of Hydrologic Alteration) are strong developed related from the hydrologic environment of Kaoping River. This caused a further decrease and increase of hydrologic environmental impact effect. Quite general, any significant deviation from normal has an unfavorable effect on the hydrologic environment. Ricter(1996) opposed the following equation (1)

to calculate the degree of hydrologic alteration (D-value); where D:Degree of hydrologic alteration, No:Number of observation (year), Ne:Number of predication (year)

$$D = \left|\frac{\mathrm{No} - \mathrm{Ne}}{\mathrm{Ne}}\right| \times 100\% \quad (1)$$

Tab. 1 The output data calculated by using IHA Analysis

IHA Classification		Degree of hydrologic alteration (D:%)			
		Ai-Liao River Sandimen Township		Qishan River Shanlin Main Bridge	
1st group	The average of annual discharge	1 month:29.4	7 month:5.9	1 month:50	7 month:25
		2 month:17.6	8 month:29.4	2 month:50	8 month:0
		3 month:5.9	9 month:5.9	3 month:50	9 month:0
		4 month:17.6	10 month:41.2	4 month:25	10 month:50
		5 month:17.6	11 month:5.9	5 month:25	11 month:50
		6 month:5.9	12 month:17.6	6 month:0	12 month:100
2nd group	Extreme value of annual discharge	5.9 (min 1dy)	52.9(max 1dy)	25 (min 1dy)	0(max 1dy)
		5.9 (min 3dy)	52.9 (max 3dy)	25 (min 3dy)	25 (max 3dy)
		5.9 (min 7dy)	5.9 (max 7dy)	25 (min 7dy)	0 (max 7dy)
		17.6 (min 30dy)	5.9 (max 30dy)	50 (min 30dy)	0 (max 30dy)
		17.6 (min 90dy)	5.9 (max 90dy)	0 (min 90dy)	25 (max 90dy)
		Q(min 7dy) / Q(yr) : 17.6		Q(min 7dy) / Q(yr) : 75	
3rd group	Time of extreme discharge	Min:52.9		Min:75	
		Max:29.4		Max:50	
4th group	Duration and frequency of max & min discharge	Frequency of low discharge:64.7		Frequency of low discharge:100	
		Frequency of high discharge:5.9		Frequency of high discharge:25	
		Duration of low:41.2		Duration of low:75	
		Duration of high:64.7		Duration of high:25	
5th group		Decrease ratio of discharge:5.9		Decrease ratio of discharge:75	
		Increase ratio of discharge:17.6		Increase ratio of discharge:75	
		The reverse frequency variation between high & low discharge:29.4		The reverse frequency variation between high & low discharge:75	

CONCLUSIONS

GPS/GIS/RS integrated technology with IHA analysis & HEC-RAS model can be used to identify the high potential impact risk or probability of hydrologic environment variation.

The output data from IHA analysis can be used to identify the possible impact on the hydrologic environment variation. The drought season has been extent at least 2 months after Morakot typhoon attack. However, the frequency of heavy rainfall was also increase more than 20% before Morakot typhoon occurrence.

According to 32 hydrologic indicators (**Tab. 1**) input to the IHA analysis model, all results illustrate that the degree of variation (D-value) have 7 hydrologic parameters can be classified as medium impact on the environment variation. However, 8 parameters are grouped into high degree of impact variation, especially including increasing on the duration and frequency of rainfall discharge, concentration of suspending loads were rising up 25~33% more than before and almost 60-day extension of dried season in Kaoping watershed.