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AN ANALYSIS OF DISCHARGE AND WATER LEVEL CHANGES DUE TO WEIR

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ABSTRACT

Our country, Korea, lacks the per capita water endowment because of the high population density and geographical characteristics. Therefore, The 4 Rivers Project has been promoted since 2009. In order to control effectively drought or floods caused by abnormal climate and strong rainfall in summer, it was done and completed in 2013. The Nakdong River is the longest in the 4 Rivers Project, which it was conducted among the country's major rivers, and a lot of hydraulic structures were installed. We selected Nakdong and Weagwan stations which are located in the Nakdong River. Because the change was smaller there with the inflow of tributaries flow than elsewhere. And many hydraulic structures were installed between Nakdong and Weagwan stations, which used T/M machine to collect real-time data.

In this study, we compared and analyzed the flow change of real-time and water level data of prior to weir installation on May, June, July, 2009 and completion of weir installation on May, June, July, 2013. The original purpose of installing the weir is well-kept. After installation of Hydraulic structures(weir), the discharge difference between the Nakdong Station and Weagwan Station was reduced , and both of Nakdong and Weagwan stations are almost maintain a constant value of water level without being affected by rainfall. Also, we could confirm that the maximum water-level variation is decreased after installation of the weir. Based on this, we judged that hydrological effects on drought or floods due to abnormal weather were decreased by the time of weir installation.

1. Introduction

The Korea, because of the characteristics of the terrain, has little fresh water than rainfall. In addition, population density is high and the annual rainfall is 1,283m, it's 1.3 times the world average 973m, but precipitation per head is 2,705㎥/year, the world's 22,096㎥/year. It is only 12%, very few. And most of the rainfall are concentrated in the summer, and rain storage facilities is insufficient when summer season, spring and fall of Korea to the agriculture at 20%

of the country, occurs drought, massive flooding caused by heavy rain has occurred as frequently as going to the abnormal weather phenomenon. Four Major River Restoration Project has been promoted from the second half of 2009 to bring the effects that decide to respond effectively to these issues. In four major river(Han River, Nakdong River, Kum River, Youngsan River), Seomjin River, and other tributaries constructed 5 dams, 16 weir, the 96 reservoirs spending 22 trillion won total project cost it was promoted to the goal of finishing the construction work in four years. Among the river, The Nakdong River has been constructed 8 weirs; it had completed the current installation in 2013. We are anticipate that the river had been changed hydrological status, water ecology, water quality etc. by the installation of weir.

In this study, we selected observatory of located in Nakdong river that a lot of weir had been constructed by 4 Rivers project to see the hydrological change before and after the installation of weir. And, we compared and analyzed real-time flow rate and water level data.

2. Target of study

Nakdong River is the place where most number of weir constructed by four river restoration project. If you see picture 1, the distance between Nakdong Observatory and Weagwan Observatory is 46km.

Table1. Characteristic of Observatory

	Nakdong	Weagwan
Observation Model	T/M	T/M
Address	Nackdan-kyo, Nakdong-myeon, Sangju-si, Gyeongsangbuk-do	Gucheol-kyo, Weagwan-ri, Weagwan-eup, Chilgok-gun, Gyeongsangbuk-do
Longitude	128° 18′ 05″	128° 23′ 39″
Latitude	36°	36°
Competent Authority	Ministry of Land, Infrastructure, and Transport	Ministry of Land, Infrastructure, and Transport
Watershed area(㎢)	9369.00	11074.4

Table2. Weir characteristic located between Weagwan – Nakdong

	Nakdan Bo	Gumi Bo	Chilgok Bo
Total length (m)	286m (Fixed weir 144.4, movable weir 141.6)	374.3m (movable weir 103.5, Fixed weir 270.8)	400m
Manage Water Storage Capacity (㎥)	34.7million	52.7million	75.3million
Characteristic	Multi-weir Form	Turning type watergate & Lift gate	Main watergate (Lift gate) & Sub Watergate (Turning type watergate)

Figure 1. Status of Nakdong River

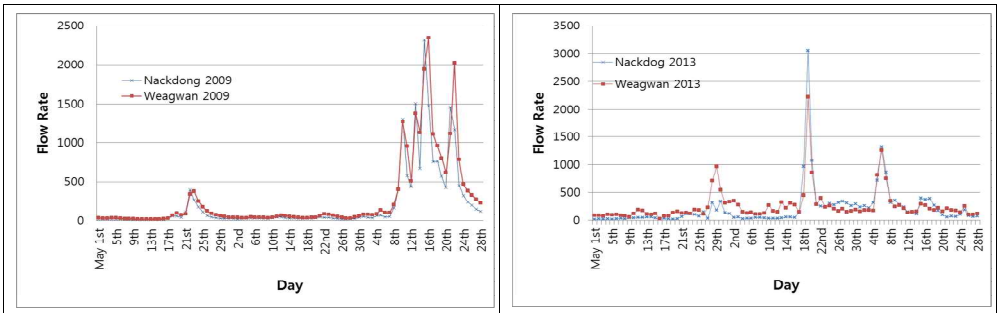
3. Real-time flow rate, water level data analysis

Three weirs used in this study were start constructed in the second half of 2009 and were completed 2012. Thus, we had compared 2009 and 2013 by real-time flow rate and water level, Compared period was May 1st ~ July 28th. Rainfall is the influence factor on flow rate and water level. May-July 2009 Nakdong's total rainfall was 449mm, and May-July 2013 Nakdong's total rainfall was 455mm, There are no difference in rainfall, so, we think that rainfall was no influence on flow rate and water level.

3.1 Comparison of flow rate at two observatories

The figure 2-a is a graph comparing flow rate in 2009. Gets less rain in May-June, the average flow rate in Nakdong was 42.23㎥/s, and Weagwan was 61.71㎥/s. Gets lot of rain in July, the average flow rate in Nakdong has greatly increased to 564.81㎥/s, and Weagwan was 709.97㎥/s. July's average flow rate in Nakdong was 13.4 times more than May-June's average flow rate, and Weagwan was 11.5 times. The average difference between upstream of Nakdong and downstream of Weagwan is approximately 35.8%

The figure 2-b is a graph comparing flow rate in 2013. Due to heavy rain in 2013, 18 to 21 June(4 days), the flow rate of the Nakdong increase rapidly increased to a maximum of 3059.11㎥/s but in Weagwan flow rate was increased to 2215.19㎥/s. Comparing to maximum flow rate of Nakdong and Weagwan, Weagwan's flow rate decrease can be seen approximately 72.4%. The average value of the flow rate from May-June in the Nakdong was 182.71㎥/s, Weagwan was 249.95㎥/s. And that of July in Nakdong was 288.55㎥/s, Weagwan was 277.49㎥/s. The average of flow rate in July was larger than that of May-June at Nakdong 1.6times, at Weagwan 1.1times. The difference between the flow rate of the difference in 2009 were 12% and 10% on the level. The average difference between upstream of Nakdong and downstream of Weagwan is approximately 53.2%, this difference is more larger than 2009.



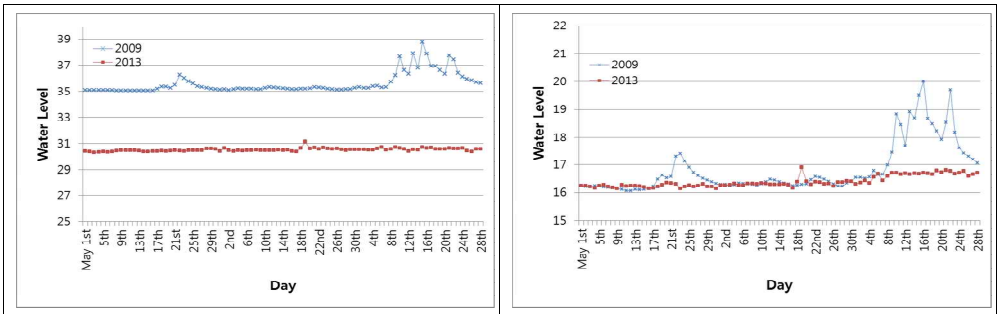
a. 2009 b. 2013

Figure 2. Graph of flow rate between Nakdong and Weagwan Observatory

3.2 Comparison of water level on 2009·2013 at two observatory

From Figure 3-a, Water level of 2009 is higher than 2013 about 4m and the water level in May-June was keep constantly regardless of presence or absence of the weir(2009 : about 35m, 2013 : about 30.5m). But in July, a rainy month, water level before the weir has built has risen rapidly up to 4m. On the other hand, water level after the weir has built is maintained as water-level in May-June (30.52m). The water level variation in 2009 3.14m, in 2013 0.63m, value has decreased by 2.52m.

From Figure 3-b, the average water level of the May-June of 2013 and 2009 is similar as 16m. But you look at the July, water level in 2009 has changed from minimum 0.5m to maximum 3.3m, on the other hand, water level in 2013 has changed up to 0.5m and maintained. After the weir has built, At Weagwan May-July water level was maintained at 16.3m.



a. Nakdong water level b. Weagwan water level

Figure 3. Graph of water level at Nakdong & Weagwan Observatory

4. Conclusion

We selected Nakdong Observatory and Weagwan Observatory for the study, and compared and analyzed flow-rate and water-level of 2009 before installation of weir and 2013 after completion of weir construction. The following conclusions were obtained.

(1) Comparing the results of real-time flow-rate data, as a result, we were founded that difference of flow-rate between observatories of 2013 is decreased about 27.7% than 2009.

(2) Comparing the results of real-time water-level data, as a result, 2013's maximum variation of water-level of the Nakdong observatory and Weagwan observatory is decreased than 2009 (Nakdong : 2.52m, Weagwan : 2.68m). And water-level maintained almost constantly.(Nakdong : 30.52m, Weagwan : 16.38m)
(3) The results of Comparing real-time water-level data on 2009 and 2013 at the Nakdong observatory, Overall, 2013's water-level is lower than 2009 about 4m. And June and July had been exposed flooding by heavy rainfall, but water-level maintained constantly as May.
(4) After weir construction, variation of flow-rater and water-level by rainfall is less than weir is not installed. So, we think that hydrological effect that caused by abnormal climate such as drought of floods is lower than before weir is not existed.

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