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**ECONOMICAL AND SYSTEMATICAL EVALUATION ON RAINFALL  
HARVESTING SYSTEM.  
(CASE STUDY : RAINFALL HARVESTING SYSTEM DESIGNED IN  
TAEBAEK CITY, REPUBLIC OF KOREA)**

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**ABSTRACT**

Recently, climate change has caused drought to become more frequent and is becoming one of the serious natural disasters, resulting damages in infrastructure facilities, economy and private property losses etc.

Taebaek city of Gangwon-do lies in the northeast Korean Peninsula along the steep mountain slopes, all the way to the sea. Thus, this city exhibits the Marine Climatic Characteristics. During the past 10 years, the average rainfall of Taebaek city is 849.9mm/year, which is less than the average rainfall for the whole country (1,274mm/year). In the period after July 2008, the 6 months rainfall amount is only 141.2mm. And in the months from August to October, the water supply was restricted to 50%. Moreover, the penetration rate of water supply of Taebaek city is only 86.1%, which is lower than the nationwide average of 93.5%. The price of water supply is 1,278won/ton, which is the most expensive. This means that the self-sufficiency of water supply is very low in Taebaek city. In order to ensure the self-sufficiency of water supply of Taebaek city, this paper aims to describe the implementation of Rainfall Detention Facilities in the open fields of primary, middle and high school as well as propose the plan of water resource demand and supply.

The population of Taebaek city is about 50,000 with water consumption about 13,250m<sup>3</sup> per day (water usage per person per day is 265L). In Taebaek city, there are 13 primary schools, 6 middle schools, and 4 high schools, therefore it is possible to achieve a catchment area of up to about 130,000m<sup>3</sup>. Through this method, about 45,000m<sup>3</sup> of rainfall water can be stored, which amounts to about 1/3 of the water supply in the case of emergency.

Furthermore, the design of the Water Quantity of Rainfall Detention considered the reuse of water for purposes like the toilet flushing, recreation, gardening and cleaning in the school. And this will save about 100,000won per month on the water bill.

Till now, the research has finished the assessment for the available catchment area coming from the primary, middle and high schools in the Taebaek city. Also, the assessment of Rainfall

Detention Quantity and the water saving costs in different scenarios (school types and water use purpose) has been completed.

This research is still ongoing. The next assessment will be on the construction cost of rainfall harvesting system (through school types) and the LCC (Life Cycle Cost) of Maintenance Administration. After which, discussion for the impacts Rainfall Harvesting System on the water supply self-sufficiency of Taebak city will be made. Lastly, conclusion on the future economic benefit for Taebak city will be given.

### Estimating the economic and social effect

Social effect (Inflation): As shown in Table 1 the price of Chinese cabbage in 2010 increased twice compared to the previous year price in February 2009. The spring drought occurrence in Taebak seems the major cause of increasing the prices.

National Emergency Management Agency (NEMA, 2009)

Table 1. Variation of Yearly and monthly prices of Chinese cabbage (unit: Won)

| Monthly | 2006  | 2007   | 2008  | 2009   | 2010   | 2011   | Average |
|---------|-------|--------|-------|--------|--------|--------|---------|
| Jan     | 5,412 | 2,335  | 4,208 | 3,143  | 4,930  | 12,668 | 5,449   |
| Feb     | 6,507 | 2,154  | 3,968 | 3,525  | 7,573  | 9,749  | 5,579   |
| Mar     | 8,347 | 2,613  | 4,563 | 5,769  | 10,839 | 9,732  | 6,977   |
| Apr     | 7,923 | 3,230  | 5,311 | 11,682 | 12,787 | 5,841  | 7,796   |
| May     | 5,278 | 2,646  | 3,380 | 9,003  | 8,337  | 2,093  | 5,123   |
| June    | 2,597 | 3,804  | 3,090 | 3,561  | 4,925  | 2,195  | 3,362   |
| July    | 3,361 | 5,441  | 2,830 | 3,937  | 7,773  | 5,647  | 4,832   |
| Aug     | 8,674 | 5,452  | 5,235 | 6,009  | 6,662  | 9,707  | 6,957   |
| Sep     | 6,443 | 16,519 | 5,490 | 3,926  | 8,843  | 8,806  | 8,338   |
| Oct     | 4,396 | 12,974 | 3,089 | 3,029  | 8,150  | 2,784  | 5,737   |
| Nov     | 2,667 | 8,746  | 2,994 | 3,364  | 7,649  | 2,883  | 4,717   |
| Dec     | 2,438 | 10,023 | 3,244 | 3,194  | 5,459  | 3,141  | 4,583   |
| Average | 5,476 | 4,815  | 3,842 | 5,121  | 9,341  | 6,131  | 5,787   |

Source: Firming affordability of radish and Chinese cabbage in Gangwon-do, RIG (2013)

The worst drought of 104 years return period is observed in 2012 and continued until 2013. After surveying the wholesale market price in June 2013 it was observed that within a week cabbage price was increased 392won/kg to 522won/kg (33.2%). In addition, compared to the previous year the cabbage price was increased 39.9%.

The price of highland cabbage was increased 2.6 times during June to August in 2013. According to the Seoul agriculture and fisheries food corporation, 1st July 2013 the cabbage price (3 fresh cabbage/10kg) was 5,337 won, later in end of July it was 10,000 won and in the beginning of August it was 13,670 won. This cabbage prices inflation is obviously the occurrence of high temperature (350C) and drought as well as the climate was analyzed as a major factor (20th July 2013).

Economic effect or small-scale storage facility installation effects: The small-scale rain water storage facility installation is proposed for harvesting rain water using the precipitation frequency analysis. The rain on the roof top of a house can use this high-quality natural water

storage facility. The storage specifications of various water tanks were presented in Table 2. However, two different types of efficient water tank facilities were proposed which are available in the domestic market. In order to analyze drought consequences in 2012, the storage facility was installed in 1st January 2011. During the installation the tank was empty and the evaporation temperature was not considered. Utilizing the Taebaek precipitation data the storage capacity were evaluated and excess rainfall may cause the overflow.

Table 2. Storage specifications of various water tanks

| No. | Water Tank specifications (litter) | Price   | Diameter (m) | Height (m) | Catchment area(m <sup>2</sup> ) | Tank volume (m <sup>3</sup> ) | Tank volume (litter) | Remarks                |
|-----|------------------------------------|---------|--------------|------------|---------------------------------|-------------------------------|----------------------|------------------------|
| 1   | 1,000                              | 120,000 | 1.08         | 1.42       | 0.92                            | 1.3                           | 1300.8               |                        |
| 2   | 2,000                              | 200,000 | 1.45         | 1.47       | 1.65                            | 2.4                           | 2427.4               |                        |
| 3   | 3,000                              | 250,000 | 1.54         | 2.04       | 1.86                            | 3.8                           | 3799.8               | Ready-made (preferred) |
| 4   | 4,000                              | -       | 1.75         | 2.04       | 2.41                            | 4.9                           | 4906.8               |                        |
| 5   | 5,000                              | -       | 2            | 2.04       | 3.14                            | 6.4                           | 6408.8               |                        |

This small-scale rain water storage/harvesting facility for two months (July to August) can enhance the irrigation for growing Chinese cabbage cultivation. Even though we considered 200L storage facility which can be extended further capacity depends on the daily demand of usage. The variation of precipitation and rain water storage tank capacity is presented in Fig. 1.

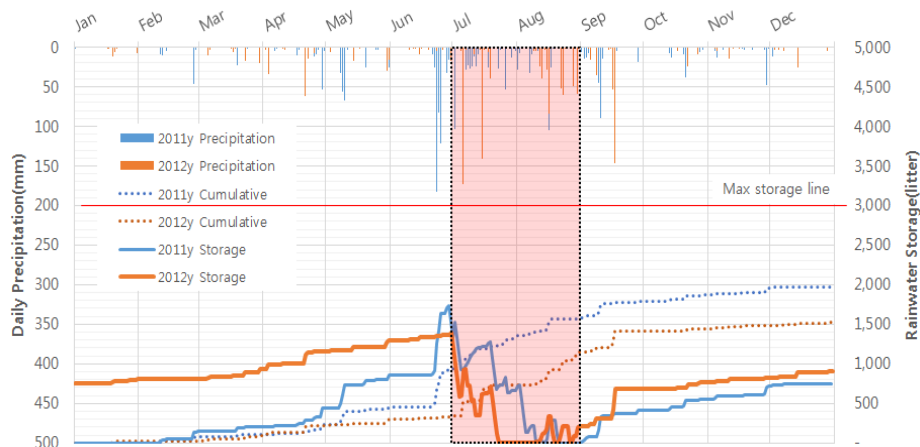


Fig. 1. Variation of rainfall and rainwater storage tanks (3000L) storage capacity

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