



Progress of Multipurpose and Proactive Rainwater Management in Korea

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Abstract

Despite the most severe weather and geological conditions, Korean people in earlier times were successful in maintaining sustainable water supplies because they understood the importance of rainwater management, and developed technologies and a philosophy which were needed to live under such circumstances. Recently, the Korean people have suffered frequent incidence of flood damage and drought, and have gradually started to remind themselves of the lessons of the past, which can be described as proactive, multipurpose rainwater management. Most of the problems associated with water and energy can be solved by the integration of rainwater management practices. The concept of multipurpose rainwater management and two examples of its practice are discussed. One is a design for a multipurpose rainwater tank which has been used in a building project, and is based on Korean philosophy. Secondly, a regulation was promulgated recently in Seoul that requires the building of rainwater tanks in new buildings over a certain size. The primary purpose is for the prevention of flooding, but water conservation is a secondary intention. Two examples of proactive rainwater management are discussed, one being public involvement in rainwater management, and the second being the rainwater piggy bank microcredit project. In order to maintain sustainability, to meet the requirements of the Millennium Development Goals, and to be prepared for the effects of climate change, it is expected that multipurpose and proactive rainwater management will be a very effective approach for both developing countries and developed countries. A worldwide network of scientific researchers, as well as a great number of professions, has suggested the promotion of rainwater management.

Keywords: Chuk-u-gi, Climate change, Multipurpose, Proactive, Rainwater management, Sustainability

1. Introduction

Korea is recognized as the most difficult area for rainwater management because of the combination of its adverse weather and geological conditions. The distribution of rainfall is uneven, which is typical for monsoonal areas, and about 70% of the country is mountainous with steep rocky slopes. The average annual rainfall and its standard deviation in Korea and selected other countries is shown graphically as Fig. 1. The variability of the rainfall in Korea is the most severe in the world, although many countries have been experiencing increased variability as a result of climate change, which has recently resulted in a slightly upward shift of the point for each country on Fig. 1. Despite the harsh weather and geological conditions, Korean ancestors maintained the country “as beautiful as silk embroidery”. Perhaps, looking back through history, we can find solutions for today from knowledge of the old culture and traditions. Multipurpose and proactive rainwater management is very helpful to the sustainability of developed countries, but it also helps to meet the Millennium Development Goals (MDG) for developing countries [1-3]. Therefore, in this paper, a new paradigm is sug-

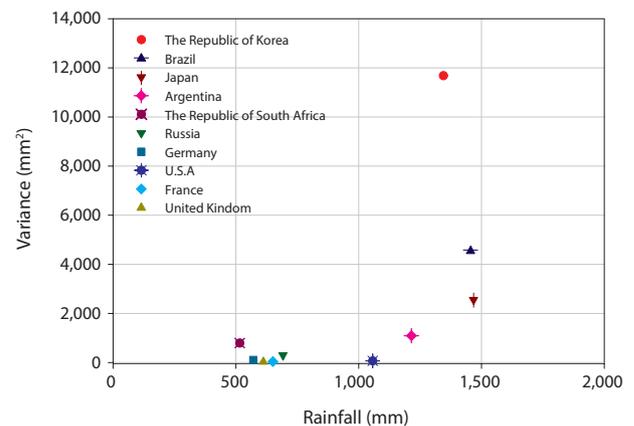


Fig. 1. Comparison of annual rainfall and dispersion for selected countries.

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gested where rainwater is managed on a decentralized basis, being controlled near its source and involving local activities. The concept of multipurpose rainwater management is suggested to create a more efficient management system, and some examples of multipurpose and proactive management are introduced

2. The History of Rainwater Management in Korea

In the history of the Gochosun, the first kingdom in Korean history established in 2333 BC, the importance of rainwater management is well described. Dangun Wanggeom, the first King of Gochosun, ruled the country with his three teachers, who were the masters of rain, wind and cloud. The master of rain, named “Woosa”, must have been a very well-practiced expert in rainwater management. The ruling philosophy was “to benefit every party”, which might mean that people living upstream should take heed of the needs of people and the environment downstream. This is nowadays called a win-win strategy.

During the later Baekje dynasty, several reservoirs were constructed. One of these is Byeokgoljae, constructed in 330 AD (length and height of the bank, 3.3 km and 5.7 m, respectively; reservoir area, 10,000 ha). The construction technology was transferred to old Japan, where a similar structure remains in operation.

In 1441, during the Chosun dynasty, the world’s first rainwater gauge, named “Chuk-u-gi”, was invented by King Sejong the Great. It consisted of a stone foundation, a water column and a stick to measure the depth of the rainfall. From that point onwards a nationwide rain gauge network was developed and rainfall data derived from this technology were collected from local offices until 1907. Although some parts of this network have been destroyed, some 250 years of rainfall records still remain, which is a critical source of data to assist an understanding the long-term pattern of climate change. Also during the Chosun dynasty, a special agency, Je-eon-sa, was organized by the central government, the mission of which was to build and maintain reservoirs. As a result, several thousands of small man-made lakes have remained in each part of the country, mitigating flooding and drought, as well as adding to the biodiversity of our eco-friendly nation.

3. Flooding Problems and Solutions in a Congested City

Seoul city is 600 years old and has a population of 10 million. Comparison of the rainfall averages over the last five and 30 years shows the effect of climate change (Fig. 2). Overall, the precipitation has increased, with more rainfall in summer and less in spring. As a result, there are many casualties and much damage to property every year, as well as very large national investment programs to prevent flood damage.

The question arises as to whether the capacity of the existing drainage system, such as storm sewers and rivers, is sufficient, and if not, how to increase its effectiveness. The traditional way of thinking has been to increase the size of sewers, to widen rivers, or to increase pumping capacity when the capacity of the drainage becomes inadequate. The cost of upgrading is very high, and there are space and volume limitations which affect the construction of new facilities on or under roads in an urban

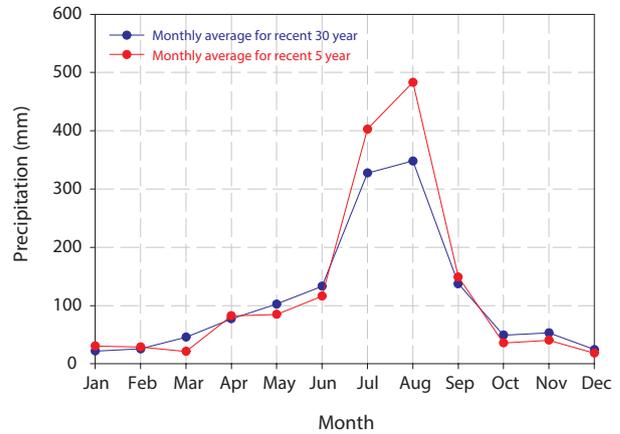


Fig. 2. The change of annual rainfall in Seoul, Korea.

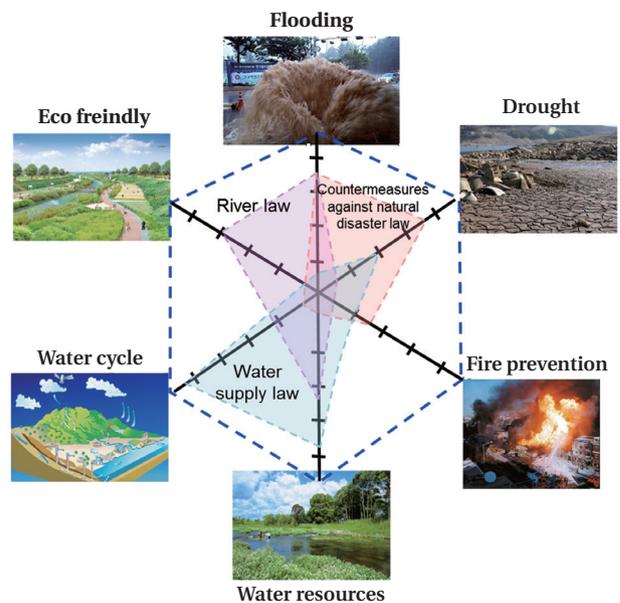


Fig. 3. Concept of multipurpose rainwater management.

environment.

An alternative solution is to manage rainfall within its watershed; that is, to store and manage the rainwater in local areas. Storing rainwater in a large number of small tanks means that peak runoff is reduced, and the time to reach peak flow is delayed. Additionally, relatively clean water stored in the tanks can be used for non-drinking purposes, resulting in water conservation. However, this approach requires the understanding and cooperation of citizens who would be responsible for the installation and management of such rainwater tanks [4].

4. Concept of Multipurpose Rainwater Management

There are many water-related problems in Korea, such as flooding, drought, water pollution, dry rivers, and mountain fires. As briefly discussed below, the severity of these problems

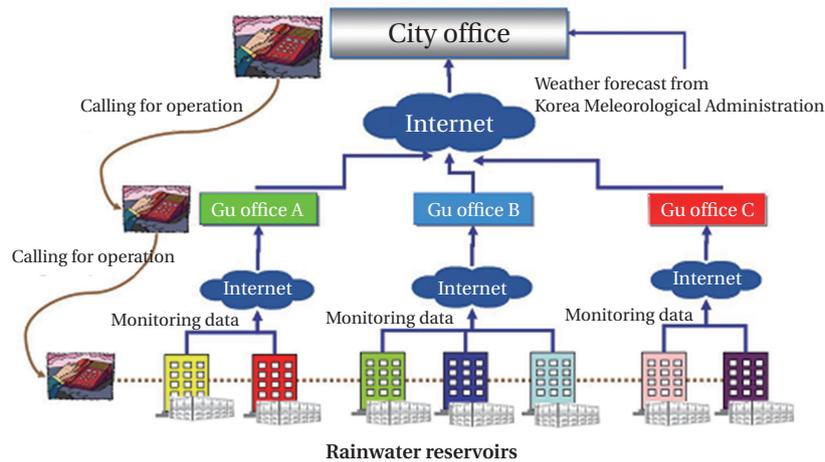


Fig. 4. Diagram showing the monitoring of a multiple tank system for the prevention of urban flooding and for water conservation.

may be mitigated if they are not dealt with as independent issues.

- 1) **Flood mitigation:** Large structures, such as dams and levees, are used for flood prevention. However, they cannot prevent flooding in all local areas, and small-scale sewer inundation occurs. These structures are not used to their full capacity most of the time.
- 2) **Drought management:** Groundwater is extracted in spring when there is no rainfall for an extended period, and is rapidly depleted. Water quality problems arise in rivers as a consequence.
- 3) **Dry river restoration:** Some rivers in the city become dry during the dry season because of the lowered groundwater level caused by slow infiltration of rainwater and by fast runoff from impermeable surfaces. Measures to pump treated wastewater effluent or river water upstream require large amounts of energy, and result in water quality problems.
- 4) **Mountain fires:** Mountain fires occur frequently in spring. However, the firefighting agency has little control over water availability. Unfortunately, mountain fires burnt a 1,000-year-old temple and its treasures in March 2005.

A number of individual ministries with their own interests and priorities deal with water problems. Solutions may sometimes be shortsighted and inefficient in national terms. The simple diagram shown in Fig. 3 illustrates this approach. Each law is shown conceptually. The river law, drawn in red, shows that the major interest is flooding, with very little concern for drought. The water supply law deals only with water resource management, with little emphasis on other major fields. An ideal management model would encompass all major items.

4.1. Examples of Multipurpose Rainwater Management

The Seoul Metropolitan Government (SMG) has been plagued by repeated damage to the city by flooding, as urban areas are covered with impervious surfaces. As a remedy, SMG is now enforcing the first example of multipurpose rainwater management.

4.1.1 Rainwater management in Seoul city

Seoul city announced a new regulation to enforce the installation of a rainwater harvesting system in December 2004 [5]. The main purpose is to mitigate urban water flooding, while the secondary purpose is to conserve water. This is expected to ensure the safety of the city and to improve the well-being of citizens as a result. Citizens are asked to cooperate by filling and emptying rainwater tanks according to directions from the disaster prevention agency.

A special feature of the new system is the provision of a network for monitoring the water levels in all water tanks at the central disaster prevention agency (Fig. 4). Depending on the expected rainfall, the central disaster prevention agency may issue an order to building owners to empty their rainwater tanks, fully or partially. An incentive program is planned for those who follow the order and some punishment for those who do not. After a storm event, the stored water can be used for firefighting and/or miscellaneous purposes such as toilet flushing and gardening.

The buildings included in the regulation are as follows.

- 1) All public buildings: compulsory for new buildings and recommended to the possible extent for existing buildings.
- 2) New public facilities such as parks, parking lots, and schools: to the possible extent.
- 3) Private buildings: recommended for new buildings subject to building permission (floor area larger than 3,000 m²).
- 4) Large development plans such as new town projects: installation of a rainwater management system as a first priority.

4.1.2. Design of a multipurpose rainwater tank in a building project

A specific rainwater system was designed for the recently constructed building in Fig. 5 through the Star City Project in Gwangjin-gu, Seoul. A 3,000 m³ rainwater tank was installed in the basement and was divided into three sections of 1,000 m³ each. The first section collects rainwater from the unpaved surface. It should be kept empty for most of the time except when there is heavy rain. The second 1,000 m³ section collects rainwater from the roof, which should be used for toilet flushing and landscaping purposes. The third 1,000 m³ section should be filled

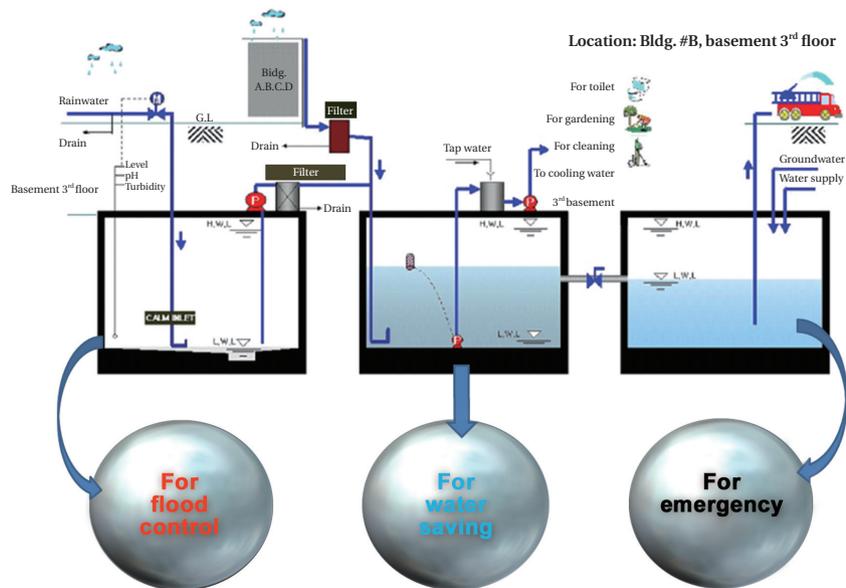


Fig. 5. Example of multipurpose rainwater tank design in the Star City, Seoul, Korea.

with fresh water and used for supply during emergencies, such as severe drought or firefighting. This project has been awarded the International Water Association (IWA) 2010 Project Innovation Award [6, 7].

4.2. Examples of Proactive Rainwater Management

The new paradigm is to manage the whole watershed on site rather than managing the river after gathering all the rainwater in its watershed. Source control, to manage the rainwater at the place it has fallen, has advantages with respect to water quality and quantity. However, contrary to the existing centralized water management, such a system requires the understanding and cooperation of the people in order for such decentralized management systems to be effective. This requires proactive rainwater management, involving education of the public, school children and the army. Some examples of education about rainwater and its promotion have been introduced. A strategic rainwater piggy bank microcredit project has been designed in order to promote rainwater harvesting at a household level. A worldwide network was also formed through the IWA.

4.2.1. Education and public awareness

In order to promote decentralized rainwater management, understanding about the fundamental water problems of the public and their active involvement is of the utmost importance. Education is important for both early schoolchildren and adults. About 50 schools in Gyeonggi Province have installed a rainwater utilization system for the purpose of education about rainwater. More schools have become interested in environmental education using rainwater as a part of an incentive program to reduce their water rates by using rainwater.

Special programs about the importance of rainwater are broadcasted in the Seoul Broadcasting System (SBS) on a regular basis. Goseong city opened the Rainwater Museum at the Dinosaur Expo and attracted many children and parents for education, as well as the promotion of Rainwater Harvesting and



Fig. 6. Rainwater system used for the rainwater piggy bank microcredit.

Management. This project received IWA 2012 Global Project Innovation Award with the theme of “Rainwater Revolution: From Drain City to Rain City by Training Brain Citizens” [8].

4.2.2. Rainwater piggy bank microcredit project

A special rainwater promotion program is in progress to encourage the installation of rainwater collection systems at the individual household level in Seoul city and Suwon city. The system consists of a downpipe rainwater filter, a 400–1,000 L rainwater tank (piggy bank), a water meter and an optional infiltration box (Fig. 6).

So far 59 cities in Korea made regulation to subsidize the rainwater harvesting facilities, several of which, including Seoul city and Suwon city, have passed regulations to subsidize 90% of the installation cost (less than 5 million Korean won) of rainwater piggy banks.

4.2.3. Worldwide network in IWA

A worldwide network to promote rainwater harvesting and management is needed to involve experts as well as citizens by using websites and internet conferences. The experiences of one country may be very helpful to others. The experiences of the older generation may also be helpful to the current generation. Rainwater Harvesting and Management Specialist Group have been organized in IWA, and several articles about the rapid progress of Korean rainwater harvesting have been published in IWA Water21 journal.

5. Conclusions

In order to meet the requirements of the MDG and achieve sustainability in the ever-increasing adverse consequences of climate change, it is necessary to shift the paradigm of rainwater management. This method not only includes relevant technology, but also introduces a natural philosophy, not only using advanced techniques, but also incorporating lessons from past wisdom. Multipurpose and proactive rainwater managements need to be developed using creative ideas, and worldwide networks to promote rainwater management are required to allow the exchange of knowledge and experience by groups of both experts and citizens.

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