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Construction Scenario for Water Supply Infrastructure in North Korea

Oh, Sangmin^a, Kim, Minju^a, Kim, Sangyup^a, Cho, Hunhee^{a, *}, Kang, Kyung-In^a

^aSchool of Civil, Environmental and Architectural Engineering, Korea University, Anam-Dong, Seongbuk-gu, Seoul, Republic of Korea

Abstract

The plan on residential supply in North Korea is needed for stabilization of Korean Peninsula after unification. While infrastructure and building construction are essential parts of this preparation, water-supply infrastructure is to be considered as a first step for establishing a stable residential environment. An arranged database on water resources in North Korea is primarily needed in order to plan for a mass supply on water-supply infrastructure and residential construction. Therefore, this study proposes a database of water resource in North Korea and a construction scenario on water-supply infrastructure. The results of this study are expected to be used as probable data for the construction of water-supply infrastructure in North Korea.

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Keywords: Water resource; Construction scenario; North Korea; Korean peninsula; Infrastructure

1. Introduction

The Korean government is in need of preparing for unification scenarios on the stabilization of the Korean Peninsula. In preparation of these scenarios, the government is collecting and analyzing information on the current environment and infrastructure of North Korea. Due to the diplomatic policy of North Korea towards other countries that resulted in a long-term disconnection with the outside, current method of collecting information on the environment and infrastructure of North Korea is indirect through literature and satellite photographs. Since information on environment and infrastructure of North Korea is currently collected indirectly using satellite photographs, most of the information inevitably has low accuracy compared to that of direct method processed via survey or observation. Nevertheless, current diplomatic policy of North Korea restricts access to information on North Korea that is necessary for supplying infrastructure in North Korea.

Meanwhile, massive defection of North Korean is expected to be caused by the famine after unification of Korean peninsula [1]. Under the current situation with the lack of information on current environment and infrastructure of North Korea, there is a difficulty on preventing the famine by constructing infrastructure in the North. From the point of view of constructing infrastructure in North Korea, systematically collecting information on environment and infrastructure in a certain target area is a first step towards providing decision-making standards on appropriate size and location of infrastructure under consideration of resource supply. A comprehensive and systematically organized information on environment and infrastructure also serves as an important factor for improving a efficiency on the rehabilitation plan for existing infrastructure in North Korea.

Although this indirect method of collecting information on the environment and infrastructure of North Korea has strengths in terms of applicability in more diverse fields compared to a direct method, there is certain information that cannot be collected caused by an exclusive diplomatic policy of North Korea. For example, the lack of information on

hydraulics and water resources in North Korea makes it difficult to prepare scenarios for constructing water-supply infrastructure in North Korea right after the unification of the Korean peninsula. In order to solve this difficulty, it is necessary to systematically collect the information on water resources in North Korea, which serves as a raw database on preparing scenarios for constructing water-supply infrastructure in North Korea.

Therefore, this study is conducted to collect raw data by using indirect method and analyze the data and extract necessary information for collect information on water resources in Hwanghaenam-do – a province in North Korea - for constructing water-supply infrastructures in the region after the unification of the Korean Peninsula. Also, this study proposes a scenario of water-supply infrastructure construction for assisting the decision-making process on the size and location of water-supply infrastructure in Hwanghaenam-do region after the unification of Korean peninsula.

The indirect method for collecting information on water resource in Hwanghaenam-do is conducted by comparing satellite photographs of Hwanghaenam-do and reports on water resources in the region. To prepare the scenario for water-supply infrastructure construction in Hwanghaenam-do, the collected information on environment and infrastructure of the region is used as the database for the decision-making process on the size and location of water-supply infrastructure construction in the region.

2. Literature Review

With a vast plain and abundant water resource in the region, Hwanghaenam-do has been served for specific purposes such as cultivating food and covering food consumption of North Korea [2]. After unification of Korean peninsula, the government of South Korea has to invest in infrastructure that can satisfy food consumption of North Korean for preventing massive defection. Thus, constructing water supply infrastructure in Hwanghaenam-do and utilizing the region as food supply area can prevent massive defection of North Korea. In this reason, prior to developing a plan on constructing water supply infrastructure in Hwanghaenam-do, collecting information on water resources in the region is preferentially needed.

There are less than ten reports that collected and analyzed information on water resource in North Korea, and the information under scope of these researches is less than 5% of the total observable water resource. There has been a study that included databases on approximate location of water resource in Hwanghaenamdo [3], but there has been no research that contained information on watermark area and volume of water resource in the region that is necessary for the decision making of size and location on the infrastructure. Thus, an absence of these information makes it difficult to decide the precise size and location of water-supply infrastructure in the region after unification of Korean peninsula.

Most of the previous studies focused on the rates of water usage in North Korea by roughly comparing total volume of water resources in North Korea and the demand for people living in the country [3]. Those studies insinuated a total amount of water resource in North Korea after unification, but the results did not consider the famine caused by shortage on capacity of water-supply for people living in the North. This famine could be cause of the massive defection of North Korean after unification of Korean peninsula.

Since the Ministry of state construction is not deeply concerned with managing water supply in the country, residents in the North solve the water-demand through reservoirs by themselves. This phenomenon is caused by the interior condition of North Korean water-supply. In the literature, however, information on water resources in North Korea is only focused on river and lake, and neglects the importance of reservoir. The number of river and lake in North Korea is less than 1% of the total water resources in North Korea [4]. Therefore, if the government wants supplying water to North Korean after unification of Korean peninsula, the government will have to collect information on reservoirs in North Korea.

In order to supply water resources immediately after the unification of the Korean peninsula, water-supply infrastructure should be constructed using reservoirs which account for the largest amount of water resources existing in North Korea. Due to the immediacy of stabilizing the regions in North Korea, applying the method using the existing water resources in the North for constructing water-supply is preferred to methods of applying modern technologies of the South that takes a long time for application. Thus, this study provides the database of information on size of reservoirs in Hwanghaenam-do and calculates approximate volume of the reservoirs using watermark area - volume correlation graph. Also, this study proposes a construction scenario of water-supply infrastructure in North Korea after unification of Korean peninsula.

3. Methodology

In order to collect the information on water resources in Hwanghaenam-do, it is necessary to collect precise information on location of water resources based on comparing satellite photographs of Hwanghaenam-do and literature. To compare the information on location of the water resources, collecting and analyzing the previously proposed information in literature is primarily need. The scope of research in previous literature is restricted to village. Thus, satellite photographs of Hwanghaenam-do region of North Korea were used to verify the location of reservoirs.

3.1. Location of water resources

The information on approximate location of the water resources in Hwanghaenam-do is collected and analyzed to classify into city or county, as follows (Table 1):

Table 1. Information on location of water resources.

Province	City	Number of reservoir
Hwanghaenam-do	Haeju	4
	county	Number of reservoir
	Kangryong-gun	27
	Kwail-gun	4
	Paechon-gun	9
	Pyoksong-gun	22
	Pongchon-gun	9
	Samchon-gun	33
	Songhwa-gun	5
	Sinwon-gun	11
	Sinchon-gun	14
	Anak-gun	13
	Yonan-gun	9
	Ongjin-gun	31
	Ryongyon-gun	8
	Unryul-gun	5
	Unchon-gun	16
	Changyon-gun	10
	Chaeryong-gun	2
Chongdan-gun	6	
Taetan-gun	6	

The number of water resources in Hwanghaenam-do is 244, and 238 of 244 water resources exist as reservoirs. The information on location of water resources in literature is accuracy, so correcting the information is conducted before calculating the reservoir.

3.2. Watermark area and Volume of water resources

In order to collect the total volume of water resources in Hwanghaenam-do, information on the watermark area and volume of each water resource is needed. First, the watermark area of water resources (Figure 1b) is calculated by extracting area (Figure 1c) from polygon covering the water resource of satellite picture (Figure 1a). These polygons consist of multiple points located on the border of water resources.

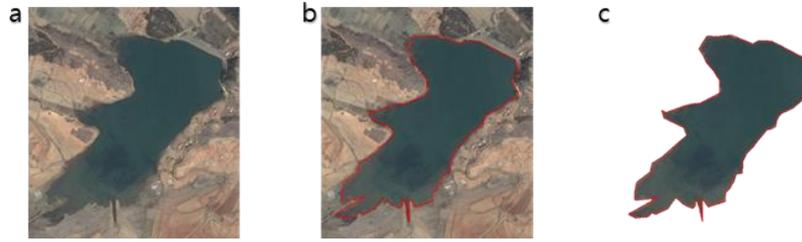


Fig. 1. (a) satellite picture of reservoir located in Hwanghaenam-do; (b) watermark area of the reservoir; (c) extracted area of the reservoir.

The volume of water resource is linearly proportional to the watermark area [5], thus allowing the calculation of the volume of water resource. In this study, we calculate the volume of water resources based on watermark – volume correlation graph (Figure 2a) and empirical correlation graph (Figure 2b) of Iksan.

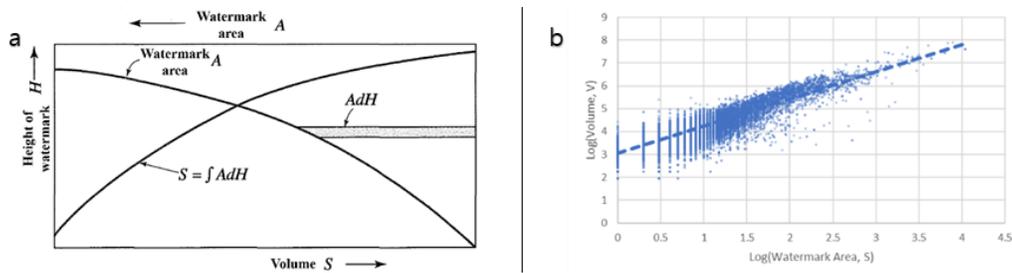


Fig. 2. (a) watermark area – volume correlation graph [6]; (b) correlation graph of reservoirs located in South Korea.

3.3. Construction scenario on water-supply infrastructure

Table 1 that has been previously proposed shows that the water resources in the 20 counties and cities of Hwanghaenam-do are evenly located. However, due to the difference in volume of water resources, it is necessary to secure the efficiency of water supply through an optimal construction scenario of water supply infrastructure in Hwanghaenam-do. Thus, the scenario includes information on size and location of water supply infrastructure to be constructed.

In this study, decision-making on size and location of infrastructure to be supplied in future is conducted by finding overlapped area of concentric circles figuring the characteristics of water resources. Concentric circles are regulated by the average size of the water supply infrastructures in Iksan city adjacent to the Kum River basin located in Honam Plain, the largest granary zone in South Korea. These maps below show concentric circles of the water resource and infrastructure as figure 3a and figure 3b respectively.

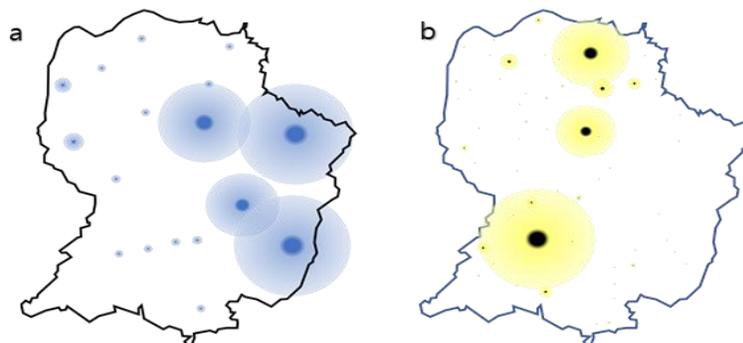


Fig. 3. (a) volume of water resource located in Iksan; (b) water-supply infrastructure located in Iksan.

The map of Iksan (Figure 3) shows that water resources and water supply infrastructures is uniformly located. The construction scenario of water supply infrastructures on Iksan city is the result of long-term preparation under thorough investigation of water resources. Due to inaccessibility to construction sites and shortage of time in case of unification of the Korean Peninsula, this study has problems conducting a simulation concerning all size and location of resource and infrastructure. Thus, this simulated scenario by limiting the scope of the size and number of infrastructure.

4. Results and Discussion

4.1. Information on water resources

The information on the location and watermark area, and volume of water resources in Anak-gun, a district in Hwanghaenam-do, is collected through the comparison of previous researches (Figure 4a) and satellite image (Figure 4b).

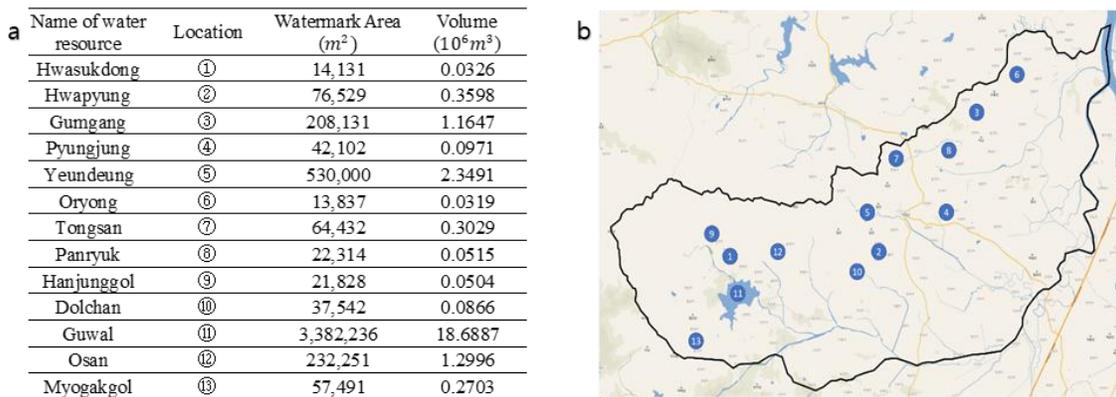


Fig. 4. (a) information on water resources located in Anak-gun; (b) map of spots marking the location of water resource.

4.2. Construction scenario of water-supply infrastructure

The information on the location and size of concentric circles (Figure 5a) and the infrastructures that can be constructed immediately after the unification, located in the map (Figure 5b) based on the analyzed database on water resources.

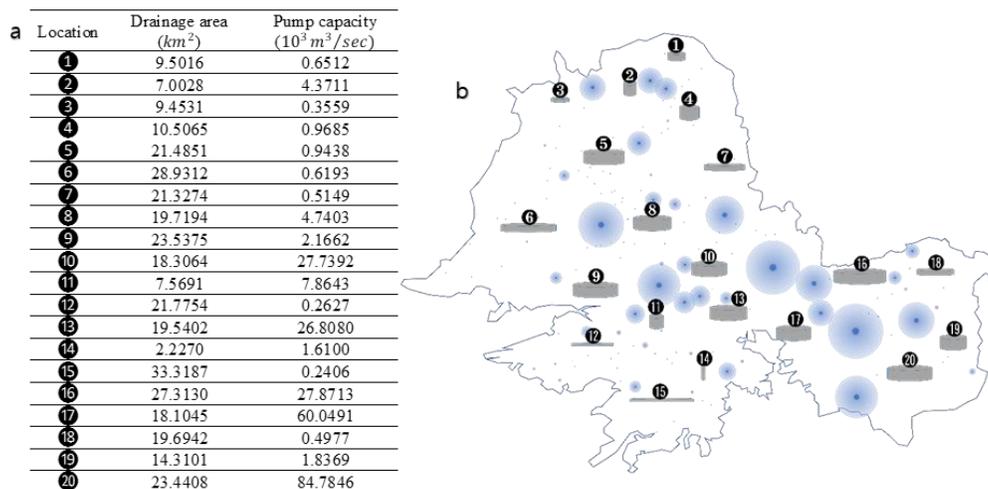


Fig. 5. (a) result of simulation of construction scenario; (b) map of Hwanghaenam-do showing the information on infrastructure.

4.3. Discussion

The water resources concerned in this study account for only seven percent of the total water resource in Hwanghaenamdo, in response to the number of facilities but they have 60 percent volume. There 23.1 million residents in Hwanghaenam-do, and 58.1 percent of them are engaged in agriculture [2]. The required volume of water resources for residents engaged in agriculture and other residents are respectively about 270 cubic meter per second(CMS) and 11 CMS, insinuating that about 281 CMS is needed for every resident of Hwanghaenam-do. The total volume of water resources calculated in this study is 1.27 billion tons, and about 255 CMS can be supplied for water-supply through the construction scenario.

The volume of water resources concerned in this study contains only 60 percent of the total volume, showing that the total volume of water resources in Hwanghaenam-do can satisfy the water usage for residents. However, Figure 5b shows the possibility of suffering from famine in the western part of Ryongyon-gun after unification because of shortage on capacity of the water-supply infrastructure. The shortage on capacity of the infrastructure in the region is caused by shortage of water resource, so this shortage can be solved by supplying the water from another region through improved infrastructure in a long-term. The results of this study show that a stable supply of water is possible for the residents in Hwanghaenam-do after unification.

5. Conclusion

This study proposed the construction scenario of water-supply infrastructure as an alternative to the pandemonium that may arise after unification of Korean peninsula. The proposed scenario could be made by collecting the information on water resources in North Korea that did not exist in literature with the level of details proposed in this study. Previous studies have reported that about 1 million North Koreans would escape from their country due to famine after unification [1]. However, Hwanghaenam-do is the largest granary zone in North Korea and is regarded as an area in which such massive defection of North Korean does not occur. The results of this study show that the food resources produced in the Hwanghaenam-do under stable water-supply can minimize the famine that may arise after unification.

Previous studies on water resources in North Korea have low applicability due to limitations of research scope, and thus cannot be used as data to be pre-emptive measure against the famine after unification. This study proposes these results to be used as factors for constructing infrastructures that can provide drinking water and irrigation water for residents of Hwanghaenam-do after unification based on the information on water resources in Hwanghaenam-do. The scenario suggested from this study expects that North Korea can be able to secure water and food resources through the water-supply infrastructure and provide a stable environment.

This study does not comprehend all regions in North Korea for proposing construction scenarios. Exclusion of other regions is due to lack of information on the spread of population in North Korea. The lack of information makes it hard to decide the characteristics of the infrastructure and to propose a sufficient number of infrastructure to be supplied when simulating the construction scenario. To overcome this difficulty, future research is needed to subdivide the scenario as short-term, medium-term, and long-term. The subdivided scenario is expected to be able to supply water resource more stably for residents living in North Korea.

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