Policy Proposals for Promoting the Development of Alternative Water Resources

By

NAM, Kwangwook

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC MANAGEMENT

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Committee in charge:

Professor Lee, Junesoo, Supervisor Junesoo Lee

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Approval as of May, 2020

Executive Summary

Due to climate change, regional and temporal precipitations have become increasingly irregular, which brought adverse water management conditions such as regular drought and large flood damage. Furthermore, demands for relaxation of “water supply area protection” regulations are increasing while expectations for clean water are raised, which has intensified regional conflicts to secure clean water.

Nevertheless, it is difficult to build a new dam due to limitations of social acceptability, regional oppositions and more strict policies on building dam of the new government. Therefore, in order to effectively utilize the limited water resources in Korea, the development of alternative water resources is necessary.

The primary purpose of this policy recommendation is to activate the alternative water resources. Whereas previous studies have carried out research on the development of the alternative water resources on certain areas like the reuse of waste water or seawater desalination, this paper intends to integrate development measures in alternative water resources areas. But the purpose of this study is not simply to integrate development measures in each alternative water resources areas. Instead, the research is primarily focused on suggesting holistic ways to the development of the alternative water resources in long-term perspective that can sustainably overcome water shortages.

First I presented the status of seawater desalination, the problem of regulations and systems, and finally the policy recommendations for promoting of alternative water resources are as follows: 1) policy establishment and the policy direction dualization for each purpose. ; 2) for small facilities, strengthen support and push ahead continuously facility improvement projects, standardize and reduce operating costs. ; 3) for large factories, strengthen networks with global companies to lead overseas markets, establish partnerships with the government, industry and academia. ; 4) secure core technologies through active development of alternative

water resources-related technologies, and an efficient operation management system ; 5) the optimal location for each characteristic of alternative water resources should be selected. For example push seawater desalination facilities around coastal areas where industrial parks are developed.

Second what can we learn from the case of Busan city? That is how important and difficult it is to have good governance among stakeholders. In the future, the alternative water resources business is expected to become more active, and it will not be possible to proceed without a good governance not only between regions but also within their own areas.

Third each alternative water resource sector, which has been handled by different departments in K-water, should be integrated into one department, and the field without a staff should create and manage a new team. The next chart shows an example of the integration of its functions into one department.

Finally in order to make a social consensus on promoting of alternative water resources, the exercise in public relations and education on water resources-related personnel should be taken into consideration.

It seems appropriate to limit the present study because there is a limit to expanding the study to the detailed plan of each alternative water resources, which goes beyond the scope of this study. Instead, the results could present a big picture about the overall development of alternative water resources.

I am sure alternative water resources are the only way to solve the water problem in Korea. I hope that the government will pay a lot of attention to alternative water resources and carry out the above proposals.

TABLE OF CONTENTS

Ⅰ. Introduction 7

Ⅱ. Literature Review 9

Ⅲ. Analysis and Findings 12

1. Sample analysis - Seawater desalination 12

2. Case study - Busan city's trial and error 16

3. Organization analysis of K-water 17

4. The alternative water resources as a solution for water conflict 21

VI. Conclusion 22

1. Policy proposals 22

2. Limitation and subsequent research 24

References 25

Ⅰ. Introduction

Due to climate change, regional and temporal precipitations have become increasingly irregular, which brought adverse water management conditions such as regular drought and large flood damage. Furthermore, demands for relaxation of "water supply area protection" regulations are increasing while expectations for clean water are raised, which has intensified regional conflicts to secure clean water (K-water, 2014).

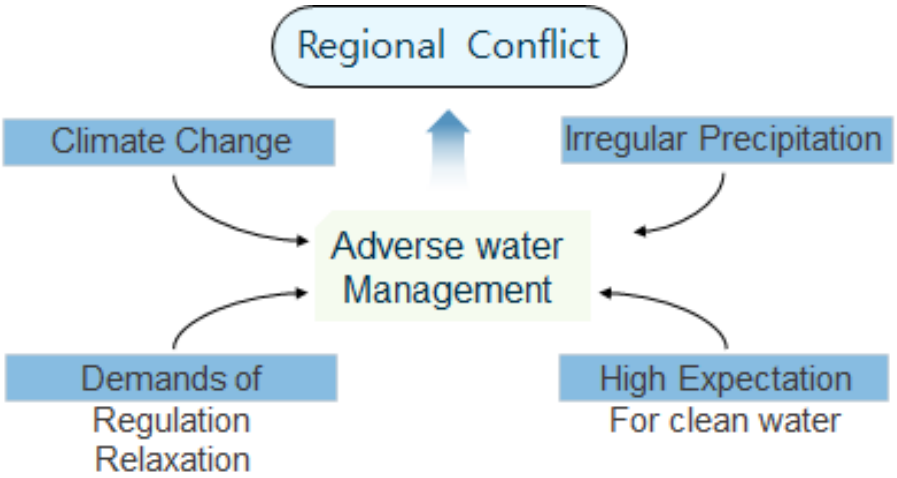


Figure 1. Adverse water management

Nevertheless, it is difficult to build a new dam due to limitations of social acceptability, regional oppositions (MOLIT, 2016) and more strict policies on building dam of the new government (Ministry of Environment, 2018). Therefore, in order to effectively utilize the limited water resources in Korea, the development of alternative water resources is necessary.

So what are alternative water resources? According to MOLIT (2018), alternative water resources functions as water sources in areas where water is difficult to secure and increase the efficiency of water use. Actually, these are not readily available such as river water, reservoir, dam and underground water. Examples of alternative water resources include seawater desalination, building of groundwater dam, the use of rainwater and filtered water along the river, etc.

Recently, there has been a growing literature in analyzing and suggesting the development of alternative water resources (K-water, 2014; ME, 2018; MOLIT, 2018). Since the development of alternative water resources vary by sector, researchers have focused on a specific area, respectively. For example, some concentrates on the development of rainwater (Han, 2000), and others on the reuse of water (ME, 2018) and groundwater dam (MOLIT, 2012).

Unlike other studies that review specific sectors, a paper by K-water (2014) attempts to take an overall approach to the issue and provides suggestions to developing alternative water resources. The approach expanded from other studies, but the parts were not wholly integrated. Similarly, MOLIT (2016) has extensively reviewed alternative water sources, but rather in a level that is too simple and little in content.

Whereas previous studies have carried out research on the development of the alternative water resources on certain areas, this paper intends to integrate the specific topics discussed in different reports. I also intend to explore the most recent dataset for the data referred in earlier reports. In terms of government responses, although K-water (2014) and MOLIT (2015) briefly discuss solutions to resolve water shortage, systematic and deep discussions on how the Korean government planned the development of alternative water resources are still limited.

In this research, therefore, I aim to analyze how alternative water resources have developed, then propose future policies in this direction. The following research questions will guide this research paper: 1) how has the alternative water resources development been implemented? 2) if it has not been implemented well, what might be the reason for it? 3) how can the development of alternative water resources be implemented well in the future? Having provided a context of this research paper, I will now proceed to review secondary literature on the development of alternative water resources.

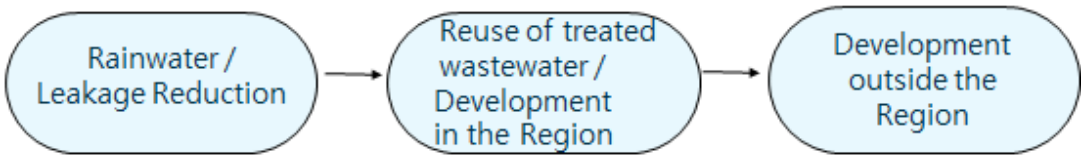


Figure 3. The order of the government's review on water resources utilization (ME, 2018)

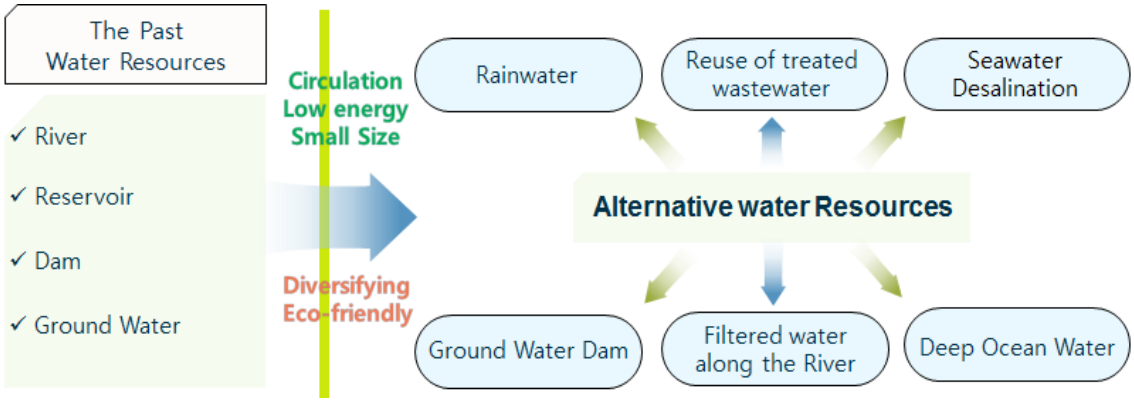


Figure 2. The change of water resources

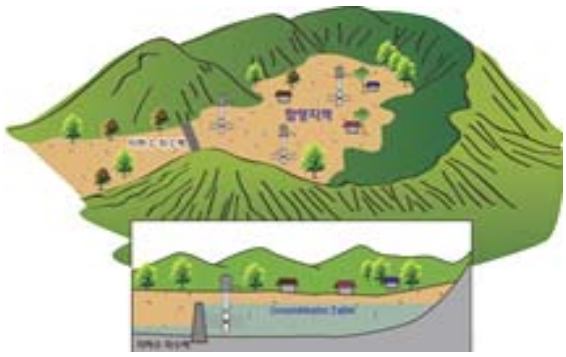
Ⅱ. Literature Review

In this section, I will provide an account of the development of scholarship in the field of alternative water resources development. The study on the development of alternative water resources has largely been divided into three parts. First is that since the development of alternative water resources varies by sector, researchers have focused on a specific area, respectively. For example, some concentrates on the development of rainwater (Han, 2000; Stec, Slys & Dziopk, 2018), and others on the reuse of water (ME, 2011) and groundwater dam (MOLIT, 2012) and seawater desalination (MOLIT, 2017) and assessing the economy (Ekin, Phoebe & Yiannis, 2009). The second is a study that attempts to take an overall approach to the issue and provides suggestions to developing alternative water resources (K-water, 2014). The approach expanded from other studies, but the parts were not wholly integrated. The third is a study that has extensively reviewed alternative water sources, but rather in a level that is too simple and little in content (MOLIT, 2015, 2016, 2018).

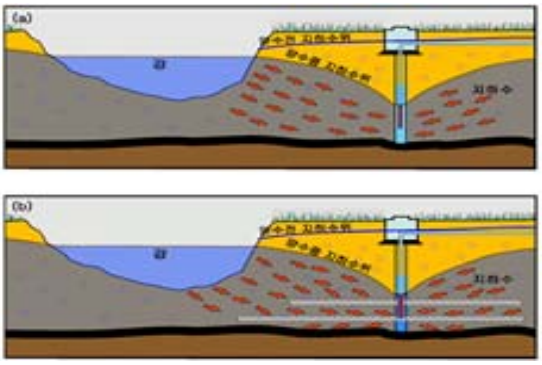
Before proceeding further, it is necessary to define clearly the key terminology referred to in this research paper. At the outset, it is imperative to clarify what we mean when we talk about “alternative water resources.” According to K-water, which is responsible for water management as a public corporation in South Korea, alternative water resources are aimed at making more efficient use of water resources with the aim of restoring water circulation, diversifying water sources, and improving water quality, away from the existing business methods of taking and using surface and underground water directly (2014). MOLIT defines alternative water resources as water sources in areas where water is difficult to secure and increase the efficiency of water use (2018). Actually, these are not readily available such as river water, reservoir, dam and underground water. Examples of alternative water resources include seawater desalination, building of groundwater dam, the use of rainwater and filtered water along the river, etc.

The use of rainwater

Seawater desalination



Groundwater Dam



Filtered water along the river

Figure 4. Example of alternative water resources

In order to achieve the purpose of this paper, having discussed alternative water resources, let us now turn to a discussion on the limitations and boundaries of this study. Whereas previous studies have carried out research on the development of the alternative water resources on certain areas (Han, 2000; ME, 2011; MOLIT, 2012; MOLIT, 2017), this paper intends to integrate the specific topics discussed in different reports. I also intend to explore the most recent dataset for the data referred in earlier reports. In terms of government responses, although K-water (2014) and MOLIT (2015, 2016) briefly discuss solutions to resolve water shortage, systematic and deep discussions on how the Korean government planned the development of alternative water resources are still limited.

The purpose of this study is not simply to integrate development measures in each alternative water resources areas. Instead, the research is primarily focused on suggesting holistic ways to the development of the alternative water resources in long-term perspective that can sustainably overcome water shortages. Based on the results, I intend to draw up the development plan of alternative water resources in the same context. Meanwhile, most previous research has not considered the expert' and general public opinions to deal with the alternative water resources. Thus, this study will expand onto different methodologies and perspectives compared with previous studies.

It seems appropriate to limit the present study because there is a limit to expanding the study to the detailed plan of each alternative water resources, which goes beyond the scope of this study. Instead, the results could present a big picture about the overall development of alternative water resources.

Ⅲ. Analysis and findings

1. Sample Analysis - Seawater Desalination

1.1 Definition

What do we mean by “seawater desalination?” According to MOLIT (2018), while the process is about removing the salt from the seawater and turning it into drinking water in a literal sense, the significance has been expanded as removing salt and other chemicals from the sea used various process technologies. K-water (2014) states that “Seawater desalination is an effort to use seawater with infinite quantity in place of the water supply system, which has relied only on surface water and underground water.” Finally, Article 3 of the Water Supply Act states that “Seawater desalination facilities are water supply facilities that are desalinated after collecting seawater or underground water containing salt due to penetration of seawater.”

1.2 Status of Seawater Desalination

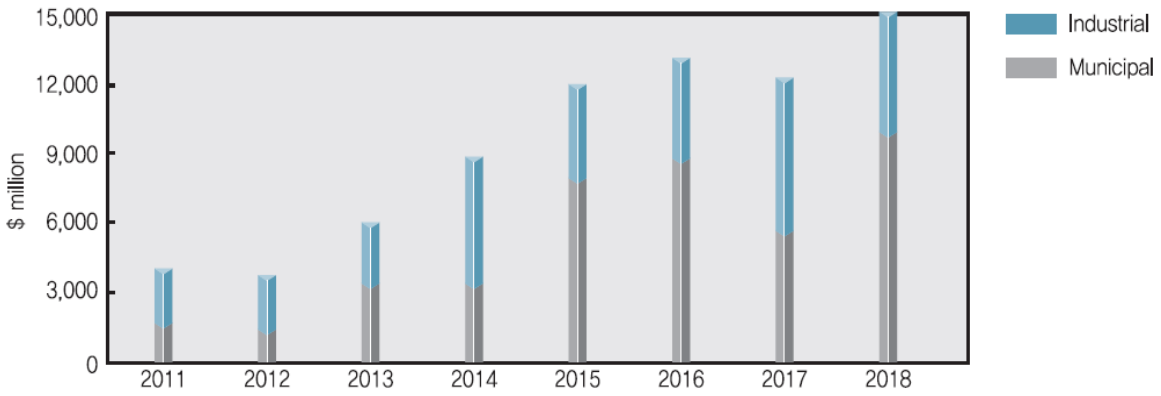
Since the early 2000s, the seawater desalination project in South Korea has been set up on a small scale with the aim of supplying drinking water to water-stricken islands. In other words, for island residents lacking drinking water seawater desalination has become a good alternative.

In addition, large-scale seawater desalination facilities such as POSCO Gwangyang Steelworks and Daesan Imhae Industrial Zone have recently been installed to secure industrial water (K-water, 2014), which are good cases of the success of alternative water resources. This is because it would have been difficult to set up a factory if the water shortage problem had not been solved.

		Region								
		sum	Incheon	Kyonggi	Chungnam	Junbuk	Junnam	Kyongbuk	Kyongnam	Jeju
Facility number	sum	101	3	3	23	7	53	1	7	4
	operate	83	1	3	22	6	44	1	3	3
	no-operate	18	2	-	1	1	9	-	4	1
Capicity (㎥/day)	sum	8,271	340	390	815	470	3,325	56	150	2,725
	operate	6,371	40	390	765	420	2,885	56	90	1,725
	no-operate	1,900	300	-	50	50	440	-	60	1,000

Table 1. Current status of seawater desalination facilities for household water

MOLIT (2018) states that "All over the world, there are currently about 15,000 seawater desalination plants with a capacity of 74.8million ton/day, and the market is expected to grow from $3.9 billion in 2012 to $15.2 billion in 2018." Furthermore, the market expansion will be accelerated by the economic security through the application of energy-reducing technologies and the expansion of facilities.



$ million	2011	2012	2013	2014	2015	2016	2017	2018
Municipal	1,917.9	1,287.7	3,182.1	3,236.9	7,923.4	8,458.0	5,671.7	9,849.2
Industrial	2,515.6	2,650.6	2,984.9	4,884.9	3,472.1	5,185.4	6,292.7	5,339.2
Total	**4,433.5**	**3,938.3**	**6,167.0**	**8,121.7**	**11,395.4**	**13,643.5**	**11,964.4**	**15,188.4**

Figure 4. Seawater desalination market forecast

1.3 Domestic regulations and systems

In Korea, the government planned to implement the seawater desalination project in a comprehensive water management plan after 2000, but currently there are no direct laws that stipulate seawater desalination and are installed under regulations such as the Waterworks Act, the Underground Water Act and the Public Water Surface Management Act. For example, the only legal basis to activate the use of seawater desalination facilities is based on the broad provision in Article 75 of the Waterworks Act: The State may subsidize or loan expenses required for waterworks to the waterworks operator.

As a consequence, small facilities used for drinking water are being shut down due to difficulties in maintenance and large factories for securing industrial water are difficult to install and maintain. None of them are supported by the system.

1.4 Overseas regulations and systems in U.S.

In the United States, a federal law named Water Desalination Act was enacted in 1996. Under the Act, the Interior Department made Water Purification Research and Development Program (DWPR), and then conducted research and supported research expenses on seawater Desalination. In California, the application of seawater desalination is expanded to solve the problem of water shortages. The "Water Security, Clean Drinking Water, the Coastal and Beach Protection Act of 2002" is specially enacted to activate seawater desalination and to support the budget. In Southern California, 10% of the total water demand is on track to be supplied by seawater desalination by 2025.

1.5 Findings

The seawater desalination facilities have been treated as small water facilities in Korea, and related regulations and systems have been poorly maintained. In the case of recent large-

scale facilities, new laws or systems are needed because they can be used as facilities for securing industrial water.

As a result, it is necessary to activate seawater desalination as follow.

√ Establish policy through legislation to support it, especially in the large-scale seawater desalination, as it is an export strategic project centered on the overseas plant market. The direction for the promotion of seawater desalination will be dualized for each purpose between small facilities and large factories. Support policies, such as incentives, can be one way to revitalize the spread of seawater desalination technology as alternative water sources.

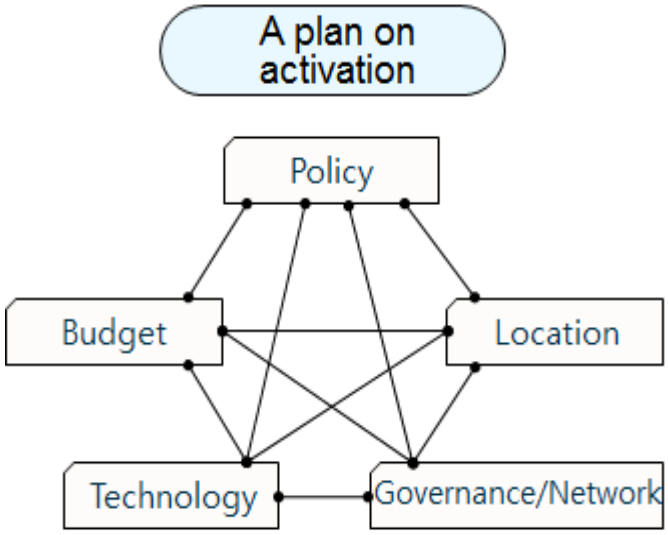


Figure 8. A plan on activation of seawater desalination

√ Strengthen support for existing small facilities and push ahead with facility improvement projects, standardize small facilities and reduce operating costs.

√ Implement diverse measures such as strengthening networks with global companies to lead over overseas desalination markets, establishing partnerships with the government, industry and academia.

√ Secure core technologies through active development of desalination-related technologies and an efficient operation management system.

√ Push seawater desalination facilities around coastal areas where industrial parks are developed as well as islands.

√ Manage governance by creating a separate water management institution to revitalize the seawater desalination business. Fortunately, a water management committee was created in 2019 as a follow-up to the integrated water management policy led by the government. In addition to water dispute management among local governments, the importance of developing and maintaining alternative water resources due to water shortages should be recognized here, and in-depth examination should be conducted throughout the entire cycle from the beginning of the project for the successful implementation of seawater desalination projects.

2. Case study – Busan city's trial and error

Busan, South Korea's second largest city, has a big problem regarding clean water supply. The reason is that the tap water is produced by purifying the lower reaches of the Nakdong River, which has very poor water quality. Accordingly, Busan had sought to bring water from Namgang Dam in Jinju City to secure clean water, but Gyeongsangnam Province opposed the plan due to the water shortage and water quality deterioration caused by lack of river maintenance water in downstream areas.

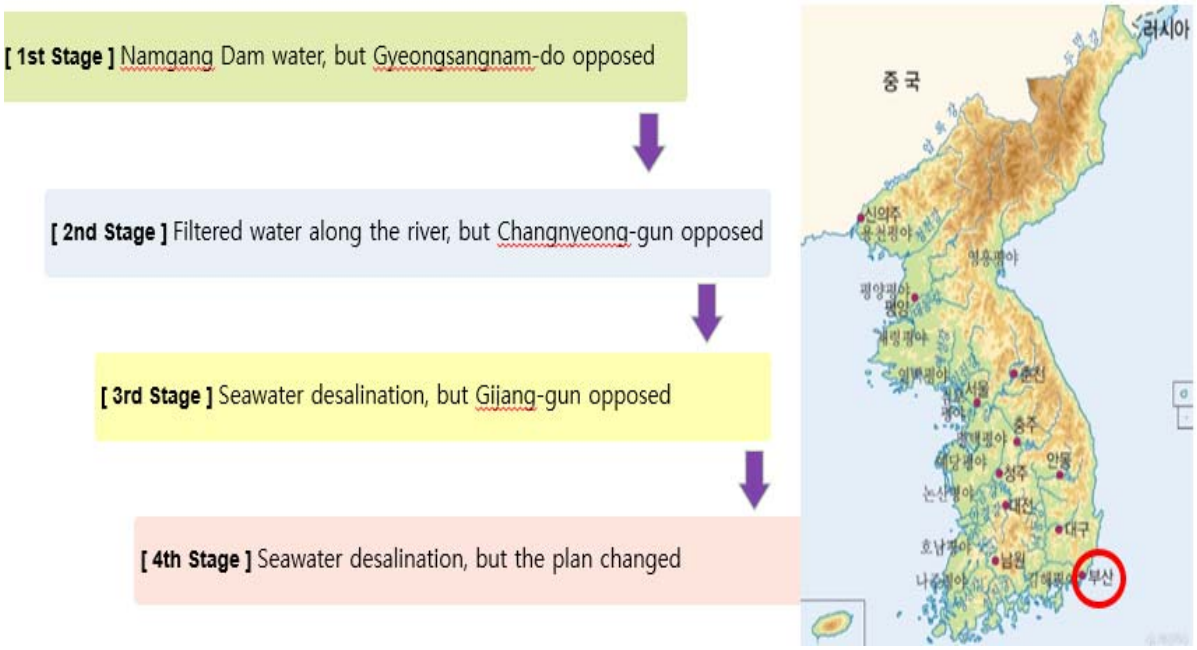


Figure 6. Busan city's trial and error for clean water supply

After feasibility study (2011, B/C 1.25), Busan developed filtered water along the river, but Changnyeong County, a district that develops filtered water along the river, opposed the water supply to Busan due to concerns over the impact of underground water levels and damage to property rights caused by various regulations. In other words, Busan has worked outside its geographical area to secure clean water, which brough regional conflicts. Finally, Busan set up a seawater desalination plant at Gijang County in Busan City in 2015 that can produce 45,000 ton/day of water to solve the problem of securing clean alternative water sources on its own. However, local residents and environmental groups campaigned fiercely against the possibility of radioactive material contamination, and eventually voted against the supply of seawater desalination as tap water at the Gijang County assembly. In case of Busan, water seems to only serve as a conflict because it caused conflicts within the region as well as between regions.

Fortunately, Busan and agencies such as the Ministry of Environment found an alternative of using the seawater desalination as industrial water rather than drinking water through a business agreement (April, 2019). **What can we learn from the case of Busan city? That is how important and difficult it is to have good governance among stakeholders.** In the future, the alternative water resources business is expected to become more active, and it will not be possible to proceed without a good governance not only between regions but also within their own areas.

3. Organization Analysis of K-water

According to Kotter (1995), there are huge number of companies try to remake themselves into significantly better competitors yet a few corporate change efforts have been very successful. He states, “The most general lesson to be learned from the more successful cases is that the change process goes through a series of phases that, in total, usually require a considerable length of time.” Bolman & Deal (1997) reveal that an organization's structure

represents its best effort to align internal activities with outside pressures and opportunities. Managers work to juggle and resolve enduring organizational dilemmas and structure represents a resolution of contending claims from various groups.

Korea Water Resources Corporation (hereafter K-water) is responsible for water supply as a public corporation in South Korea. Until now, K-water has been supplying water with stability through dam construction and water facilities for wide area supply. But, the importance of alternative water resources has recently been rising in water shortages due to climate change and difficulties in building dams caused by the change of government policies and opposition from local residents. (MOLIT, 2018)

Alternative water resources can be divided into the use of rainwater, seawater desalination, reuse of waste water, groundwater dam and filtered water along the river. K-water does not currently manage each of these alternative water resources in one department, and operates them in different departments, distinguished between water supply department and water resources department, which include underground water. The table 2 under Department -Team column shows the highlighted portions of Figure7.

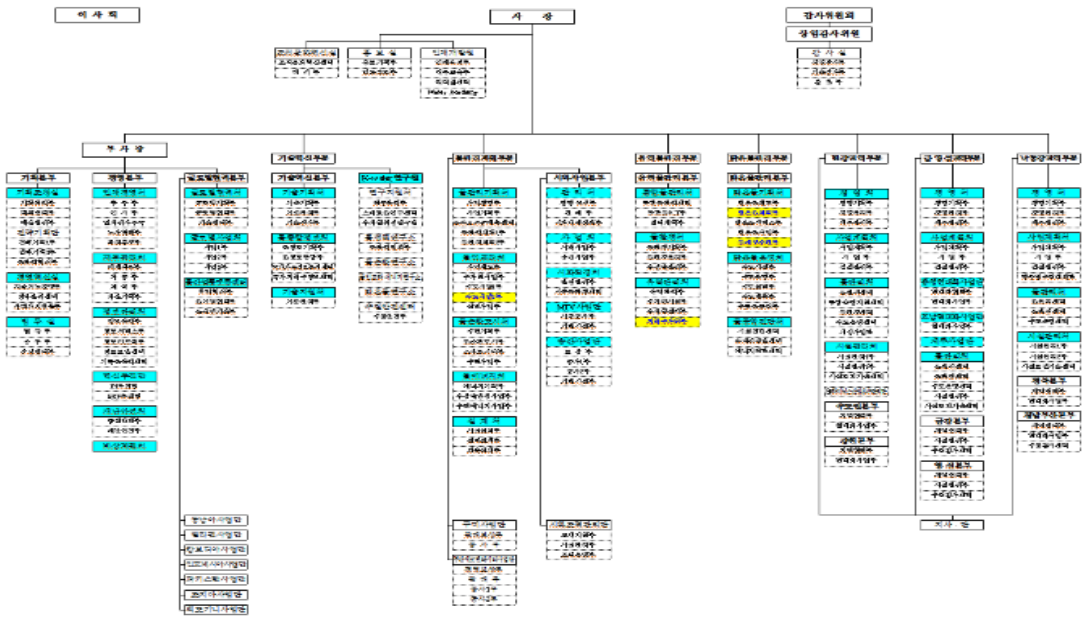


Figure 7. Organization position Chart (2019)

Alternative water resource	Department / Team	Department Category
the use of rainwater	-	-
seawater desalination	Clean Water Supply Planning Dept / Integrated Clean Water Supply Planning Team	Water supply
reuse of waste water	Clean Water Supply Planning Dept / Water Reclamation Business Team	Water supply
groundwater dam	River Basin Management Dept / Groundwater Resources Business Team	Water resources
filtered water along the river	Water Infrastructure Development Dept. / Water Supply Business Team Ⅱ	Water supply + Water resources
Over all	-	-

Table 5. Alternative water resource – Department (Team) Chart in 2019

This is the rationale that the K-water has long been strengthening and controlling internal organization by distinguishing between water supply department and water resources department, and also evidence that K-water has been systematically attempting to integrate both of them in accordance with the government's recent policy: "integrated water management," but this has not succeeded. This separation has made promotions in each field, and has used line up promotion culture in K-water to strengthen internal control over anything else.

But now, times have changed. The days of water supply and water resources have passed, and the days of alternative water resources have begun. At a time when the role of alternative resources has become more important than ever, the functions and internal compliance would be much enhanced if the management or teams could integrate into one department.

In case of filtered water along the river, there is no department in charge of planning, instead it is in charge of the actual business department. The use of rainwater should be the top priority in water resource utilization according to “Guidelines for the establishment of a basic

plan for water maintenance" (ME, 2018), but there are no departments in charge and research is conducted only in relation to Low Impact Developments in the laboratory. There are also no general oversight department, so there seems to be limitations in putting together each alternative water resources to pursue policies or to map out comprehensive measures for development. Thus, the next chapter tries to explain how to change the organizational structure to enhance its function.

Recently, there has been a growing literature in analyzing and suggesting the development of alternative water resources. Whereas previous studies have carried out research on the development of the alternative water resources on technical and political aspects, this chapter intends to enable its function by changing the structure of the organization that has not been experimented. This means that **each alternative water resource sector, which has been handled by different departments, should be integrated into one department, and the field without a staff should create and manage a new team.** The next chart shows an example of the integration of its functions into one department.

Alternative water resource	Department	Team
the use of rainwater	Alternative water resource Dept.	The use of rainwater Team
seawater desalination		Seawater desalination Team
reuse of waste water		Reuse of waste water Team
groundwater dam		Groundwater Team
filtered water along the river		Filtered water along the river Team
General / Over all		Integrated Planning Team

Table 6. Reorganization proposal chart

4. The alternative water resources as a solution for water conflict

Water has recently been a major conflict in South Korea, and here are some notable examples : 1) Conflict to secure water from Yongdam Dam between Jeollabuk-do Province and Chungcheongnam-do Province ; 2) The dispute over the right to use water and water prices between K-water and Chuncheon city ; 3) The dispute between Daegu city and Gumi city regarding, the relocation of the water intakes ; 4) The water conflict between Busan City and Gyeongsangnam-do Province against the plan to secure clean water through the Namgang Dam.

At the same time water has not just worked as a medium for conflict. An example is the sharing of unbalanced water resources through the movement of water between regions. In addition, efforts to overcome water shortages and water quality problems have been underway using alternative water sources with the recent policy of the Ministry of Environment.

However, as inter-regional water movement is now a factor in water disputes due to regional egoism, alternative water resources are considered the only way to resolve water disputes. If so, what should be considered first for the activation of such alternative water resources?

“Master plan for the maintenance of waterworks in the metropolitan and industrial areas” which is one of the nation's top water plans, explains overlapping investment is the reason on the difficulty of developing alternative water resources (MOLIT, 2015). In particular, the master plan state “the industrial water utilization plan for reuse of waste water overlaps with existing and future regional and industrial water facilities, and it is necessary to prevent overlapping investment of the national budget.”

In the reality that the national water management paradigm is shifting from the previous large-scale water development like dam to the preservation and sustainable development, the logic that the alternative water resource development is not necessary because of the overlapping plan now seems strange.

It is now necessary to establish a comprehensive new water development plan. Policy priorities of water development have clearly changed. In order to make a social consensus on this, **the exercise in public relations and education on water-related personnel should be taken into consideration.**

For example, the use of waste water van be used greatly for industrial water and river maintenance water separately from the existing multiregional water supply. Among these, river maintenance water is expected to improve the quantity and quality of water, especially for rivers with insufficient water flow. Before realizing only the redundancy and economic logic of investment, it is necessary to take a step ahead in securing local water supply independence and developing as a sustainable resource in the long term by utilizing alternative water resources through change in understanding.

Ⅵ. Conclusion

1. Policy proposals

Due to climate change, regional and temporal precipitations have become increasingly irregular, which brought adverse water management conditions such as regular drought and large flood damage. Furthermore, demands for relaxation of “water supply area protection” regulations are increasing while expectations for clean water are raised, which has intensified regional conflicts to secure clean water.

Nevertheless, it is difficult to build a new dam due to limitations of social acceptability, regional oppositions and more strict policies on building dam of the new government. Therefore, in order to effectively utilize the limited water resources in Korea, the development of alternative water resources is necessary.

The primary purpose of this policy recommendation is to activate the alternative water resources. Whereas previous studies have carried out research on the development of the

alternative water resources on certain areas like the reuse of waste water or seawater desalination, this paper intends to integrate development measures in alternative water resources areas. But the purpose of this study is not simply to integrate development measures in each alternative water resources areas. Instead, the research is primarily focused on suggesting holistic ways to the development of the alternative water resources in long-term perspective that can sustainably overcome water shortages.

First I presented the status of seawater desalination, the problem of regulations and systems, and finally the policy recommendations for promoting of alternative water resources are as follows: 1) policy establishment and the policy direction dualization for each purpose. ; 2) for small facilities, strengthen support and push ahead continuously facility improvement projects, standardize and reduce operating costs. ; 3) for large factories, strengthen networks with global companies to lead overseas markets, establish partnerships with the government, industry and academia. ; 4) secure core technologies through active development of alternative water resources-related technologies, and an efficient operation management system ; 5) the optimal location for each characteristic of alternative water resources should be selected. For example push seawater desalination facilities around coastal areas where industrial parks are developed.

Second what can we learn from the case of Busan city? That is how important and difficult it is to have good governance among stakeholders. In the future, the alternative water resources business is expected to become more active, and it will not be possible to proceed without a good governance not only between regions but also within their own areas.

Third each alternative water resource sector, which has been handled by different departments in K-water, should be integrated into one department, and the field without a staff should create and manage a new team. The next chart shows an example of the integration of its functions into one department.

Finally in order to make a social consensus on promoting of alternative water resources, the exercise in public relations and education on water resources-related personnel should be taken into consideration.

2. Limitation and subsequent research

It seems appropriate to limit the present study because there is a limit to expanding the study to the detailed plan of each alternative water resources, which goes beyond the scope of this study. Instead, the results could present a big picture about the overall development of alternative water resources. So then what are some of the research topics that need to be conducted in the future?

First, this study performed sample analysis on seawater desalination among alternative water resources. Subsequent research needs to analyze characteristics and activation methods in each field of alternative water resources in addition to seawater desalination and draw out their commonalities.

Second, there is a need to diversify case studies. This means that it is necessary to derive more ways to revitalize alternative water resources, not only in Busan, but also in various domestic and overseas cases.

Third, the organization, personnel, budget, and activities of not only K-water's organization, but also the Ministry of Environment and water-related organizations should be analyzed to determine if there are any policy suggestions.

Lastly, setting priorities for the various policies presented in this study is considered to be a significant study.

I am sure alternative water resources are the only way to solve the water problem in Korea. I hope that the government will pay a lot of attention to alternative water resources and carry out the above proposals.

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