

IJACT 20-12-25

## Maintenance of Waterscape Facilities at Garden shows in Korea

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### Abstract

We aimed to understand various problems identified at waterscape facilities of gardens built at garden shows in Korea. The main purpose of the study is to understand which parts of waterscape facility built in gardens at garden shows are causing problems and whether these problems can be traced back from garden design phase or from local communities in charge of maintenance. Furthermore, we examined if such problems get more aggregated as time passes by and different garden shows have different types of problems. In this study, types of waterscape facilities examined are pond, waterway, wall fountain, water glass, trough, mist, Cascade, fountain, rain garden, waterfall. An analysis of the maintenance status of waterscape facilities introduced in the existing gardens confirmed that problems could arise in two main respects. One is due to poor maintenance by the organizers of the garden show, and the other is due to the poor design of waterscape facilities by the garden designer.

**Keywords:** Circulation System, Waterscape, Garden Designer, Maintenance, Guide Line

## 1. INTRODUCTION

From a long time ago, water has always been an essential element of garden design along with plant [1]. This is largely because water is fundamentally linked to activities of all living organisms plus its effect on climate controlling, psychological healing, leisure and even its practical function as firefighting water.

Gungnamji in Buyeo and Wolji in Kyungju are regarded as the origins of Korean garden culture and they are built with pond. In center. In other countries, waterscape is also perceived as indispensable in garden. For example, an ancient Egyptian garden built 2500 B.C. had a sunken pond and this pond functioned not only as aesthetically, but as microclimate control. In the past, what was considered the most important for waterscape facility in gardens was water supply and its treatment. Samguksagi(The history of three kingdoms) Baekje-bongi 5th Mu dynasty has an article referring to a pond. "In March, they dug a pond in southern part of the castle and filled it with water from 50 Ri (20 km) away. Willow trees were built on 4 slopes around and an island was also built in the pond which was as big as family graveyard" [2]. From the article, we can see that water was supplied from as far as 50 Ri (20 km). Also, in case of Wolji in Kyungju, water supply came from far north.

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Manuscript received: November 25, 2020 / revised: December 17, 2020 / accepted: December 23, 2020

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When comparing with gardens in modern time, the importance of water usage is as important as gardens of the past. Especially for public gardens built in urban cities, value of water is considered to be more important. However, for modern gardens, water usage requires supply and treatment and in winter times, freezing of water is a constraint. For garden exhibition, there are problems of low budget and not sufficient review for waterscape facilities, plus negligence by communities who are in charge of maintenance.

This study aims to understand various problems identified at waterscape facilities of gardens built at garden shows in Korea. The main purpose of the study is to understand which parts of waterscape facility built in gardens at garden shows are causing problems [3] and whether these problems can be traced back from garden design phase or from local communities in charge of maintenance. Furthermore, the study examined if such problems get more aggregated as time passes by and different garden shows have different types of problems. In this study, types of waterscape facilities examined are pond, waterway, wall fountain, water glass, trough, mist, Cascade, fountain, rain garden, waterfall.

Prior studies on waterscape facilities of gardens built at garden shows in Korea are a study by Yum [4], Park [5] and Kim [6]. For more studies on garden shows in Korea, there are studies on perception change of garden shows, on garden show programs, on the value and effect of garden show, on planting, on facilities and on the maintenance of garden show [6]. The prior studies mentioned above on waterscape facilities of gardens at garden shows did not focus on waterscape facility but included all other facilities of gardens at garden show. Waterscape facility was studied as one of facilities of gardens. A study by Yum looked at 97 gardens designed at garden shows categorized facilities of these gardens into 8 types and specifically dealt with several frequencies for certain type of facilities to be introduced in a garden and their features [5]. A study by Park examined Gyeonggi Garden Festival and analyzed status of maintenance of the gardens after field research [5]. A study by Kim categorized types of facilities built at gardens in 4 garden shows and studies features in detail [6].

## **2. RESEARCH METHOD**

In this study, literature research and field research were first conducted to select waterscape facilities built in designer's gardens created at 4 garden shows. Then, we studied basic data and current status of target waterscape facilities to identify problems appeared and further examined root causes of problems with waterscape facilities through interviews with garden designers and local communities in charge of maintenance.

For literature research, we found gardens built at garden shows held so far that specifically had waterscape facilities, categorized waterscape facilities and reviewed preliminary data on each category of waterscape facilities. Literature research was conducted on story books or white paper of each garden show with detailed description or garden design drawings which were publicly accessible.

We categorized waterscape facilities based on landscape design standards to include all types of waterscape facilities such as pond, waterway, waterfall, wall fountain, rain garden, water glass, mist, fountain, and trough. For field research, we visited target waterscape facilities and collected data such as design, circulation system and current status. Also, during field research, we closely examined root causes of problems with waterscape facilities while cross-checking garden design drawings. Based on analysis result of literature and field research on waterscape facilities, we conducted interviews with garden designers and people in charge of garden shows to comprehensively understand problems related to waterscape facilities built in gardens.

Target waterscape facilities were limited to

- 1) Waterscape facility, which was built more than one year ago,
- 2) Waterscape facility built in garden show that are continued to be held and
- 3) Waterscape facility with continuing maintenance.

Details of Target waterscape facilities of the study Table 1.

**Table 1. Waterscape facilities**

Gyeonggi Garden Festival			Gyeonggi Garden Festival		
Tweet-tweet	Mist	2010	Find my bluebird	Water glass	2018
Happy Urban Kitchen Garden	Pond, Waterway Wall Fountain	2010	Moonlight majung-gil	2 Trough	2018
Gallery garden	Pond	2010	Middle East 1177, My Garden	Waterway, Pond	2018
Light metapo	Mist	2012	Seoul Garden Show		
The eyes of the city	Pond, 3Trough	2012	Mom's Garden with Stories	Pond, Waterway	2015
Birch forest garden	Trough	2012	Rainy Gardens, Homes	Waterfall	2016
Gok Woo Jung	Pond	2012	Emotional garden	Pond	2016
Forest cinema	Wall Fountain Pond	2015	Blue Garden	Pond	2017
The shelter, courtyard of my family	Pond, Cascade, Waterway	2015	To mingle separately and together	Water glass	2017
Yi Gong	Waterway, Pond	2015	8th #201	Pond	2018
Be a poem in everyday life	Pond	2015	LH Garden Show		
Ah! Jeju!	Pond	2016	PEAKnic Garden in Seoul	Rain garden	2018
Show me the Garden	Pond	2016	Scent and bubble	Wall Fountain, Pond	2018
Nested time garden	Trough 3	2016	Hide-and-seek with nature	Pond	2018
Abyss garden	Pond	2016	Vortex Garden	Pond	2018
Mash work	Pond	2016	Dongcheon	Pond, Waterway	2018
Wall, boundary of daily life	2 Pond, Waterway	2016	Cheongju Gardening Festival		
A quiet forest	Wall Fountain	2016	Mugung mountain garden	Pond	2018
Stroll Garden	Pond	2016	Mother's mind	Pond, Waterway Wall Fountain	2018
The beauty of margin	Trough	2017	Memories of woamsan	Waterway, Water glass	2018
Corridor for Pray	Trough	2017	Melodic landscape	Pond	2019
Paradise Lost	Pond, Fountain, Wall Fountain,	2017	Smile Garden	Rain garden	2019
Formative garden	Pond, Spring, Waterway	2017	Joyful Garden	Water glass	2019
Romantic feeling	Pond, Mist	2017	Garden of Child's mind	Trough	2019

### 3. RESEARCH RESULT

#### 3.1 Waterscape facility ratio in gardens built at garden shows

Ratio of gardens with waterscape facility for 4 garden shows is explained below in Table 2. LH garden show had the highest ratio of 60.0% of gardens featuring waterscape facility followed by Gyeonggi Garden Festival of 50%, Cheongju gardening festival of 41.7%, and Seoul garden show with the lowest of 11.7%. On the other hand, an analysis by year showed that Gyeonggi Garden Festival held in Ansan 2017 had the most number of waterscape facilities and Seoul garden show held in Sangamdong Peace Park 2015 had the least number of waterscape facilities in the gardens.

The reason for the highest number of waterscape facilities of Gyeonggi Garden Festival as shown in the table below is thought to be relatively more budget for garden building. And the reason why waterscape facility ratio slows down after 2016 is burden on maintenance cost. For LH garden show, we must consider

that it was held only once in 2018 and it is hard to a link between the nature of garden show and a ratio of waterscape facility. However, LH garden show set relatively more budget as by Gyeonggi Garden Festival allowing more designers in 2018 LH garden show to build waterscape facility.

For types of waterscape facilities, we found that the most frequently used type to be pond which was featured in 4 gardens of Seoul garden show, in 16 gardens of Gyeonggi Garden Festival, in 6 gardens in LH garden show and in 1 garden of Cheongju gardening festival. Next frequently used type of waterscape facility is waterway for supplying water to pond. 1 garden of Seoul garden show, 6 gardens of Gyeonggi Garden Festival, 2 in LH garden show and 1 in Cheongju gardening festival had waterway. The third frequently used type is wall fountain which was built in 5 gardens of Gyeonggi Garden Festival and 1 garden of LH garden show. 11 and 22 can also be found. 1 garden of Seoul garden show had 22 and 6 gardens of Gyeonggi Garden Festival had 11 and 1 garden had 22. Some gardens also had more than 2 11s. Other types of waterscape facility include waterfall of Seoul garden show and mist foundation & cascade built in Gyeonggi Garden Festival. Rain gardens were also found in 2 gardens of Seoul garden show and 1 in each Gyeonggi Garden Festival and Cheongju gardening festival.

Looking at pond type in more detail, we found that Seoul garden show had 1 indeterminate, 1 squared, 1 oval shape and 1 triangle combination type with no certain shape-related feature. Gyeonggi Garden Festival had 5 gardens with circle shape pond, 3 gardens with oval shape, 7 gardens with square shape, 3 gardens with free shape and 1 garden with triangle shape and we found that garden designers mostly preferred square shape ponds. In LH garden show, 2 gardens with square shape pond, 1 garden with oval shape, 1 garden with half moon shape and 2 gardens with free shape pond. In Cheongju gardening festival, there was a pond with shape of waterway and no particular pattern was found.

**Table 2. Ratio of waterscape facilities**

Name of garden show	Year	#of Gardens	#of water scape	Ratio (%)	Name of garden show	year	#of Gardens	#of water scape	Ratio (%)
Seoul Garden Show	2015	17	1	5.9	Gyeonggi Garden Festival	2010	6	3	50.0
	2016	16	2	12.5		2012	7	4	57.1
	2017	15	2	13.3		2015	10	4	40.0
	2018	12	2	16.7		2016	12	8	66.7
	Sum	60	7	11.7		2017	10	5	50.0
Cheongju Gardening Festival	2018	5	1	20.0	2018	9	3	33.3	
	2019	7	4	57.1	Sum	54	27	50.0	
	Sum	12	5	41.7	LH Garden Show	2018	10	6	60.0
					Sum	10	6	60.0	

### 3.2 Comparison of waterscape facility status when it was built and its current status

Comparing waterscape facility status when it was first built during the garden show and its current status serves as an important index for how good or poor is maintenance effort. In this study, we compared photographs of waterscape facilities and gardens taken during construction phase and their current photographs to identify differences and analyzed reasons. Photographs were analyzed per each garden show and we aimed to understand maintenance status per garden show.

#### 1) Seoul garden show

Waterscape facilities installed at gardens of Seoul garden show are pond, waterfall (Trickling system), water glass and rain garden. 4 gardens had installed a pond. We found that 3 of them were dried out. Of these 3 ponds, 2 of them were left neglected with bare ground showing and 1 was filled with black and white

pebbles transforming itself into some kind of facility than waterscape. Only 1pond was filled with water. Ponds without water did not have water circulation system that automatically controls inflow and outflow of water, thus no water supply and treatment. 1pond had water, but very turbid which failed to serve its purpose of being scenic element. Therefore, in case of Seoul garden show, designers who designed ponds should be held accountable for poor maintenance. Of course, Seoul city government is partly accountable for not reviewing water circulation system when designers submitted garden design plan with waterscape facility during the garden design contest for garden show. Next for waterways, there is no automatic water supply and naturally, there is no water flowing. For trickling system, we found system in place for electricity supply using solar panels and water supply. However, trickling system is not currently operating and we believe there is equipment related problems. Water glass was installed in one garden, but it has been removed. For rain garden, we observed no significant difference between now and in 2016 when it was built, but the rain garden needed some maintenance work since waterproof layer is sticking out and some plant looked different.

**Table 3. Comparison of waterscape facility status (Seoul Garden Show)**

Name of Gardens	At the time of Garden show	Present condition	Name of Gardens	At the time of Garden show	Present condition
Mom's Garden with Stories			To mingle separately and together		
	Pond:Clean water Water way:Flow	Pond:Muddy water Water way:No Flow		Water glass:Clean water	Water Glass:Disappeared
Rainy Gardens, Homes			8th #201		
	Trickling system:Operated	Trickling system:Inoperative		Pond:Clean water	Pond:No water Pebbles
Emotional garden			PEAKnic Garden in Seoul		
	Pond:Clean water	Pond:No water		Rain garden: Ponding	Rain garden:Ponding
Blue Garden					
	Pond:Clean water	Pond:No water			

**2) Gyeonggi Garden Festival**

We found that Gyeonggi Garden Festival had the highest number of gardens with well maintained high-quality waterscape facilities.

Our research revealed that only 4 gardens out of 16 gardens featuring pond had properly operating water circulation system for inflow and outflow into ponds. These 4 gardens were “Abyss garden”, “Marsh Walk” in Sunnam, “Forest cinema” in Ansong, and “Paradise Lost” in Ansan. For garden shows held in Sunnam, there are 2 ponds with currently working waterscape facility which proves Sunnam city government’s effort for maintenance of gardens for the garden show. There are 4 other ponds that are not working which requires more maintenance effort needed with focus on equipment. In Ansan, “Paradise Lost” has a pond with clear water which shows that water supply is working well. So, for ponds with no water currently, we believe it is not due to stable supply of water or electricity, but the problem has more to do with equipment related to pond. “Forest cinema” of Ansong has similar problems. However, we discovered that for “Paradise Lost” and “Forest Cinema”, there was some water in pond where water fountain for water inflow was not working. We believe some water in pond is likely to be managed by a separate water supply equipment or manual supply or water. For “The eyes of the city” in Suwon, the pond was filled up and covered with grass which clearly points out to poor maintenance issue. Mist fountains installed in 3 gardens were not working and same for waterways as well. Wall fountain was only operating in one garden, “A quiet forest” in Sunnam. Water stream was found to be working properly in only one place, “Abyss garden”.

Furthermore, we found no trough or water glass properly maintained with water circulation. They were merely filled with rain drops and dried out after evaporation.

**Table 4. Comparison of waterscape facility status (Gyeonggi Garden Festival)**

Name of Gardens	At the time of Garden show	Present condition	Name of Gardens	At the time of Garden show	Present condition
Tweet-tweet			Abyss garden		
	Mist: Operated	Mist: Inoperative		Waterfall: Operated Waterway: Operated Pond: Clean water	Waterfall: Operated Waterway: Operated Pond: Clean water
Happy Urban Kitchen Garden			Marsh Walk		
	Waterfall: Operated Pond: Clean water	Waterfall: Inoperative Pond: No water		Pond: Clean water	Pond: Clean Water Waterwheel: Added
Gallery garden			Wall, boundary of daily life		
	Pond: Clean water	Pond: No water		Pond: Clean water Water way: water Flow	Pond: No water Water way: No water

Light metapo



Mist: Operated



Mist: Inoperative

A quiet forest



Waterfall: Operated



Waterfall: Inoperative

The eyes of the city



Pond: Clean water  
Trough: Clean water



Pond: No water  
Trough: No water

Stroll Garden



Pond: Clean water



Pond: No water

Birch forest garden



Trough: Clean water



Trough: Flip over

The beauty of margin



Trough: Clean water



Trough: Temporary, Clean water

Gok Woo Jung



Trough: Clean water



Trough: No water

Corridor for Pray



Trough: Clean water



Trough: Temporary, Not water

Forest cinema



Waterfall: Operated  
Pond: Clean water



Waterfall: Operated  
Pond: Muddy water

Paradise Lost



Waterfall: Operated  
Pond: Clean water



Waterfall: Operated  
Pond: Muddy water

The shelter, courtyard of my family

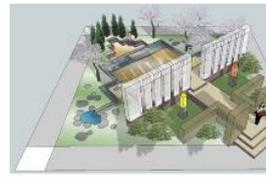


Cascade: Operated  
Water way: Water flow  
Pond: Clean water



Cascade: Inoperative  
Water way: No water  
Pond: No water

Formative garden



Water way: Water flow  
Pond: Clean water



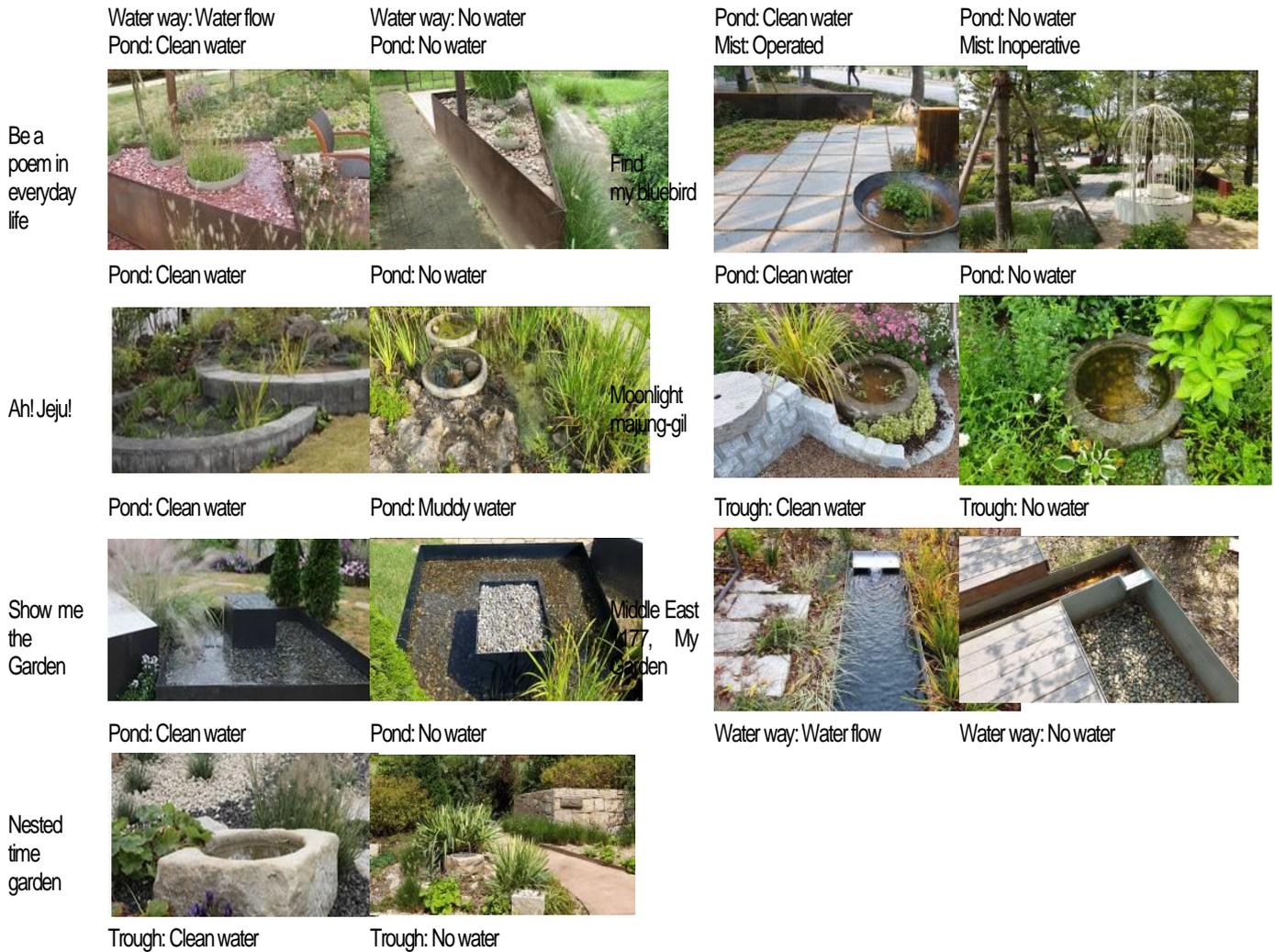
Water way: No water  
Pond: No water

Yi Gong



Romantic feeling





### 3) LH Garden show

LH garden show had 6 gardens with pond. 3 ponds are filled with water currently but with poor water quality, and 3 are dried out showing the bottom. Looking at the current status of these pond, we believe that there is no automatic water circulation even for ponds currently filled with water and probably water supply is done manually. We also believe that ponds filled with water currently has no leakage issue largely due to proper waterproof work during construction phase and it is clear that there is no equipment running for water inflow or outflow. “Scent and bubble” are an example of a pond with water, but no wall fountain running. Water stream and waterway are installed in one garden each, but they are not currently in operation which only proves poor quality of water maintenance.

**Table 5. Comparison of waterscape facility status (LH Garden show)**

Name of Gardens	At the time of Garden show	Present condition	Name of Gardens	At the time of Garden show	Present condition
Scent and bubble			Dong cheon		

	Waterfall: Operated Pond: Clean water	Waterfall: Inoperative Pond: Muddy water	Water way: Clean water Pond: Clean water Circulation system: Operated	Water way: No water Pond: No water Circulation system: Inoperative
Hide-and- seek with nature				
	Pond: Clean water	Pond: Muddy water	Pond: Clean water	Pond: Muddy water
Vortex Garden				
	Pond: Clean water	Pond: No water	Pond: Clean water Water way: Water flow	Pond: No water Water way: No water

#### 4) Cheongju Gardening Festival

There was only one garden with pond at Cheongju gardening festival. However, an automatic water circulation system was not installed, and water circulation was done manually with inconvenience. Cheongju city government decided to dry the pond and filled with pebbles. So, there is no existing garden of Cheongju gardening festival which has a pond. There is one waterway installed which was built by scraping inside of pine tree. Water pump was installed for the waterway, but unfortunately, water pump broke and currently the waterway is not in operation. Pond and trough are not working now since there is no automatic water circulation system.

**Table 6. Comparison of waterscape facility status (Cheongju Gardening Festival)**

Name of Gardens	At the time of Garden show	Present condition	Name of Gardens	At the time of Garden show	Present condition
Memories of woamsan			Joyful Garden		
	Water way: Flow	Water way: No Flow		Pond: Clean water	Pond: No water
Melodic landscape			Garden of Child's mind		
	Pond: Clean water	Pond: No water, Pebbles		Trough: Clean water	Trough: No water

Smile  
Garden

Rain garden: Ponding

Rain garden: Ponding

#### 4. DISSCUSSIONS ABOUT MAINTENANCE PROBLEMS

Our analysis on waterscape facilities of gardens at 4 major garden shows revealed that maintenance of these facilities is in poor condition and we have summarized maintenance problems as follows.

After our analysis on maintenance conditions of waterscape facilities of existing gardens, we identified 2 aspects for maintenance problems. One is the lack of maintenance efforts by the organizers of the garden show and the other one is the poor design of waterscape facilities by the garden designer.

In the first case, despite the proper operation of the waterscape facility, it is a problem caused by poor water and electricity supply, poor repair of some breakdowns, or neglect of maintenance, such as regular or irregular cleaning. In the case of the Gyeonggi Garden festival, waterscape facilities were required to be equipped with circulation systems and they are currently working well, indicating that the created waterscape facilities are operating. However, other garden shows did not have any guidelines for installing circulation systems and in fact, other garden shows did not recommend installing waterscape facilities at all. In the second case, maintenance problems can be traced to the garden designer's failure to apply an automatic circulation system while designing waterscape facilities, or the designer's complacent attitude thinking that the organizers would take care of waterscape facilities. Interviews with garden designers revealed that the costs offered by the garden show host were lower than the costs needed to build a garden, and that they decided not to install circulatory systems which are costly. In addition, the research found that the waterscape facilities did not work properly because water was supplied manually only during the fair, but immediately drained, filled with pebbles, or covered with dirt after the fair. So, without guidelines, the organizers did not make sure that circulations systems must be installed when making waterscape facilities in the gardens. As a result, garden designers ended up not installing expensive automatic circulators for waterscape facilities in their gardens.

What we were able to confirm from this study is that organizers had low awareness of maintenance, and even if they understood the need for maintenance, they could not force it because they did not have guidelines or guidelines. So, without guidelines, the organizers did not make sure that circulations systems must be installed when making waterscape facilities in the gardens. As a result, garden designers ended up not installing expensive automatic circulators for waterscape facilities in their gardens. Another confirmation is that some garden designers were not fully understand the mechanism of waterscape facilities while designing and building their gardens and had complacent attitude that it will be taken care by the organizers. Of course, there are cases where the organizers installed sufficient equipment during the garden show, but due to poor maintenance, equipment broke down or waterscape facility did not function properly due to a lack of water supply and electricity.

#### 5. CONCLUSION

We believe that such problems can be solved if a garden designer fully understands the importance of waterscape facilities, properly designs for easy and sustainable maintenance, and ensures that construction is appropriately done. Prior to that, organizers of garden shows should support with sufficient budget to cover waterscape facilities and review the design more thoroughly to provide appropriate guidelines for waterscape facilities. Organizers should do more strict review/evaluation during the design contest. In addition, there should be designated resource/team to ensure proper maintenance or certain measures should be prepared to ensure designer's participation for maintenance.

We believe that these problems will eventually be solved by the garden designer recognizing the importance of waterscape facilities, designing them properly and ensuring proper construction to facilitate maintenance and make them sustainable. Prior to that, organizers will have to pay for the construction of waterscape facilities so that designers can install them properly, while on the other hand, they should not neglect to make and distribute guidelines and guidelines to ensure that the waterscape facilities are functioning properly, and to monitor thoroughly from the screening process. In addition, organizers should consider creating a maintenance department to ensure proper maintenance or an institutional mechanism for writers to participate in maintenance.

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