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Water Treatment Measures to Improve Ecological Value in Traditional Korean Villages: The Case of Oeam Village, Asan City, Korea

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Abstract: Maintaining and improving the ecological soundness and value of Korea's traditional villages can contribute to their role as tourism resources. This study examined water treatment measures intended to improve the ecological value of one of South Korea's traditional villages by analyzing the efficiency of water treatment in a pond at the village's entrance and changes in flora around the village pond. The results demonstrated a statistically significant reduction of non-point pollutant sources flowing from the pond into surrounding farmland. Treatment efficiencies of Total Nitrogen, Dissolved Oxygen, Biochemical Oxygen Demand, and Chemical Oxygen Demand and Total Phosphorus were 75.33, 30.02, 65.52, 59.12 and 78.85 percent respectively. Moreover, changes to the flora around the village pond were analyzed. Prior to the village pond being dug, the flora consisted of a single-species gramineous plant; however, after the village pond was constructed, nine types of aquatic plants were identified, including lotus plants. The flora diversity was increased, with the aquatic plants showing strong growth. This pond function influences the reduction of pollution load for streams outside the village, and distributes the treatment effects of pollution sources that occur inside the village.

Keywords: environmentally friendly village of the future; non-point pollutant source reduction; plant species transformation; village pond

1. Introduction

Today, sustainable city development is a significant objective for urban environments. UN-Habitat has been discussing the importance of well-planned, well-governed, and efficient cities and other human settlements, with adequate housing, infrastructure, and universal access to employment and basic services such as water, energy, and sanitation [1]. The United Nations Centre for Human Settlements (UNCHS) has also established planning index and criteria to be practiced globally, and many countries around the world have strived to construct sustainable settlements in accordance with their background and circumstances [2]. Korea is also responding actively to environmental issues while the UN is escalating its efforts to achieve harmony between environment and development.

Korea is deeply interested in methods to minimize the influence on the environment when restoring ecosystems destroyed from industrialization and urbanization, and by new development. In particular, the Ministry of Environment, one of the branches of the central government, engaged in a 10-year national project to "[create] ecological streams" from 2006 to 2015, and the Ministry of Land invested a large budget in creating and restoring environmentally friendly streams that allow humans to coexist with the environment over the five-year period between 2007 and 2011 [3]. These efforts were made to improve quality of life by enhancing the comfort factor of the physical environment, species diversity, and the soundness of the aquatic ecosystems. This is because water influences the core aspects of human life. Throughout the ecological restoration of the aquatic ecosystems, traditional villages would have undertaken efforts to actively utilize surrounding environmental features and adapt to them, as they were formed before human-focused water use was maximized. We focus on the fact that traditional villages represent a concentration of wisdom as the foundation of living that is suitable for these specific lands over a long period of time.

Korean residential development planning has a history of employing traditional ancestral techniques (conventionally termed as knowledge systems) [4] as a means of ensuring sustainability and environmental integrity [2,5]. The majority of traditional Korean villages emerged autonomously, and the people who lived in them understood how to adapt to the natural environment [6]. It is fundamentally necessary to examine the evolution of water treatment techniques used in farming and daily life, because these techniques were developed as solutions to social needs [7]. The water treatment system hardware in a traditional Korean village typically included a waterway within the village, a village *bangjuk* (a water structure similar to a reservoir or pond), and a stream [2]. This structure provided living and drinking water from the community spring or streams in front of homes [8]. Domestic sewage from each household and rainwater would drain back into the river through the village waterway. Before sending water back into the river, this structure also gathered water in a designated location in the village and served as a multipurpose tool for reusing the water. In this type of water treatment system, if the volume of water in the waterway surpassed a fixed quantity after being recycled, the majority of it would follow the village or agricultural waterway and connect to a stream in front of the village. All of the water from small basins in the village would pass through the village waterway and gather at a low point in the village before exiting the village [3].

As Korea underwent modernization, the village bangjuk, which was an auxiliary measure to provide urgent agricultural water during the dry season, was reclaimed for water resource development, land-use change, and environmental improvement. Its traces vanished to the point that even the term "bangjuk" [9] fell out of use. In addition, as open village waterways reverted to past models, they were buried in the ground. However, village bangjuks and the waterways of traditional villages are now being restored or newly built as new light is shed on their value in increasing the ecological integrity of villages. It is important to focus on Oeam-ri Village, located in Songak-myun, Asan City, Chungcheongnam-do, which still uses some elements of its traditional water infrastructure. This village was designated a Traditional Village under the Cultural Heritage Protection Act on 7 January 2000, and was also designated a Folk Village as an Important Folklore Material (No. 236) [5]. Oeam-ri village features a man-made waterway that intersects the village and the upstream houses, which creates a water space that is rare in other Folk Villages [8]. The water is sourced from a small dam on the stream that flows to the south of the village before crossing through its center. The water naturally flows downstream, maintaining a smooth slope. As the water flows near the houses upstream and returns towards the houses downstream, it appears that there would have been interactions within the village community [3].

The pond built at the entrance of Oeam village, the target area of this study, was completed in 2013 through the efforts of a village conservation association. It would be inaccurate to refer to Oeam's pond as a traditional village bangjuk, which would collect all effluent water, including domestic sewage; however, it can reasonably be described as a type of village bangjuk, utilizing the village's topography, gathering farmland effluent water around residential areas, and sending it out of the village after storing it for a designated period of time. In Oeam's water treatment structure, the bangjuk's influent water is maintained as a surplus water resource for farmland, and when the water surpasses a fixed level, it naturally flows into the village waterway before entering the Oeam River. Village locals refer to this as a "yeongji" (a pond where lotuses are planted); however, in this paper, the target area is referred to simply as the "village pond".

Research on traditional Korean villages such as Suncheon's Naganeupseong Village [2,10], Hwasun's Wolgok Village [11], Changpyeong's Samjinae Village [12], Asan's Oeam-ri Village [2,5,7,8,13], and Kimcheon's Wonto Village [14] has provided observations on water cycling systems, low marshes and creeks for storm water infiltration, and plant purification systems based on system construction of water resources. This study, which was primarily conducted through observation, investigation, and a literature review, interprets water systems in traditional villages from physical perspectives, including humanistic perspectives and topography.

Water treatment is an important factor in ensuring the ecological integrity of a village's water bodies and water systems [15–17]. This study looked at Kyeongnam's Wooponeup riverside cistern [18], Chungnam's Gongju Jaemin River [19], and Kyeongi Province's Kyeongan River [20] to investigate and assess the value of water treatment. There has been substantial interest in research regarding farmland water quality issues associated with urbanization [21], improvements [22–24], and evaluation [25,26]. To improve water quality and the provision of ecosystem services in eutrophic urban ponds, research has been conducted to examine water quality improvements achieved by building floating treatment wetlands with plants from the Cyperus species, and other studies [27] have shed light on the effects of water treatment in small-scale urban bangjuks using volcanic ash and yellow iris [28].

Oeam Village, in southern Chungcheong Province, was used as a case study area in this research to assess the ecological value of water treatment systems in traditional Korean villages and address the following two questions: First, is it feasible to say that the occurrence of water treatment confirms the ecological value of village ponds? Second, what plant species changes confirm the ecological value? The answers to these questions are expected to be useful in research on the role of water treatment methods in the daily life of Korea's traditional societies and in the formation of eco-villages for future generations.

2. Materials and Methods

2.1. Study Scope and Area

The time frame for this study is from Oeam Village's formation to the present day. The village waterway was constructed after the formation of the village, and the village pond at the village entrance was constructed recently. The spatial scope of this study includes Oeam Village's pond as the central point, as well as the environment surrounding the village pond (see Figure 1).

Figure 1. The study area.

Approximately 500 years ago, the Meok clan settled in Oeam Village, which is located on a slope at the foot of Seolhwa Mountain. The Kang clan then entered and lived in the village until the period of the Yean Lee clan. The Yean Lee clan formed a village following the Myeongjong of the Joseon Dynasty. The residences of aristocrats such as Yeongam, Champan, and Songhwa still exist today, along with approximately 80 households and 400 residents. Many of the large and small thatched-roof homes remain in their original form [29].

Oeam Village features two main characteristics in the use and treatment of water. The first is the directing of mountain streams using the natural topography and slope of Oeam Village near the Seolhwa Mountain. This appears to be related to both the daily use of water and to aspects of fengshui. Another characteristic of the village is a one-block area of farmland that was recently transformed into a village pond, in accordance with a decision made by the Village Conservation Association. The village pond, which stores effluent water that accumulates in specific farmland areas in the village, provides both the ecological value demonstrated in this research and scenic value for visitors to the village.

2.2. Research Methods

This research sought to verify the water treatment efficiency of effluent water from the village's outdoor spaces, including the village pond's water treatment structure and farmland, which use Oeam Village's topographical features. This research also sought to verify the pond's instrumental role in improving the environmental ecological value of traditional villages through an analysis of surrounding plant species.

To analyze the village pond's environmental ecological value as a water treatment structure, data were collected by examining the existing literature, conducting interviews with residents, and carrying out on-site field investigations. Three types of analyses were conducted. First, the physical structure of the village pond at the entrance of village was analyzed, as well as the water quality of the village pond that acts as a sewage collection system, to assess the effect of water treatment from the village pond. Moreover, an analysis of plant species around the village pond aimed to confirm the changes in the environment around the village pond. This assessment was made by analyzing the village pond's water quality. Lastly, by examining changes in plant species around the village pond, this study verified improvements in Oeam Village's environmental ecological value (see Figure 2).

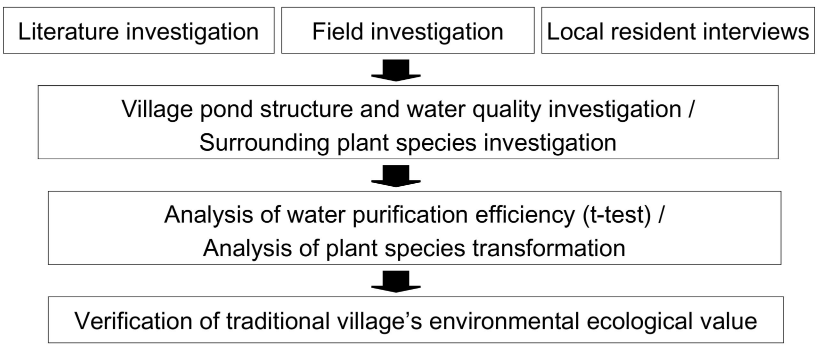

Figure 2. Research method and flow.

The field study in this research was conducted from June of 2016 to June of 2017. The quality of the effluent and influent water was tested ten times under identical conditions as part of the assessment of the plant species and water treatment efficiency of the village pond built at Oeam's entrance. We commissioned the Korea Water Resources Corporation's Water Quality Inspection Center to conduct water sampling and testing, and we analyzed and compared the effluent and influent water quality based on measures of water quality in the cistern. In addition, a *t*-test analysis was conducted to verify the significance of the efficiency of reduction of non-point pollution in the village pond. The mean values of water quality measures for the influent water that flows in from the village's farmland and waterway and passes through the village pond were compared with the mean values of the same measures for the effluent water that exits the pond. We confirmed that the pond installed in the traditional village is indeed an environmentally friendly system that reduces the pollution load in the Oeam River outside the village. Research on plant species inside and outside of the village pond was conducted by means of inspection and monitoring of all the introduced species.

2.3. Field Surveys for Collecting Presence Data

2.3.1. Village Water Treatment Structure

We analyzed the two main components of Oeam Village's water treatment system separately: the village waterway that provides water for daily living and the village pond where effluent water from the village gathers. Oeam Village's water treatment structure differs from those of other traditional Korean villages in that the waterway that provides water from the river for daily living is a separate installation. In addition, the reconstruction of the village pond at the entrance of the village in 2013 is unusual.

Village Waterway

The Oeam Village waterway is a man-made waterway that was built 300 years ago. The waterway was built for several reasons: first, to control the fengshui of Seolhwa Mountain [2]; second, to provide water for fighting fires, because the homes in the village at that time were made from wood; third, to provide agricultural water to farmland located inside the village; and fourth, to provide water for landscaping purposes in noble households and for daily use in homes [7]. In terms of the manner in which it was used, the village waterway was similar to today's modern graywater facilities [3], and it is still used for garden plants and water for daily use in individual homes in the village.

The village waterway can also be interpreted as a type of corridor that is often seen in landscape ecology [8]. In a structure in which mountain stream water from outside a village is redirected to pass through the interior of the village before flowing back out again, functions such as energy delivery, filtration, and obstruction can be verified. The physical structure of the village waterway was built in the form of a reinforcing stone wall, in accordance with the surrounding environment that contains numerous stones. While the waterway flows in the direction of the Oeam River at the village entrance, it becomes wider, and its role expands as a channel for rain water that flows to the river.

The upstream influent point of Seolhwa Mountain's stream lies at an altitude of approximately 74 m. The village entrance meets Oeam Stream at an altitude of approximately 46 m, which is 28 m lower than the influent point [5]. In the A-A′ cross-section shown in Figure 3, the altitude of major points along the manmade waterway are shown as 72 m (b) and 71 m (c) in the upper residential area where the houses of clans are located; 63 m (e), 60 m (f), and 55 m (g) in the center, close to the noble households; and 50 m (h) in the area downstream [5]. In the B-B′ cross section of the village, the altitudes of points along the manmade waterway are shown as 73 m (a′), 59 m (b′), 55 m (c′,d′), and 50 m (e′).

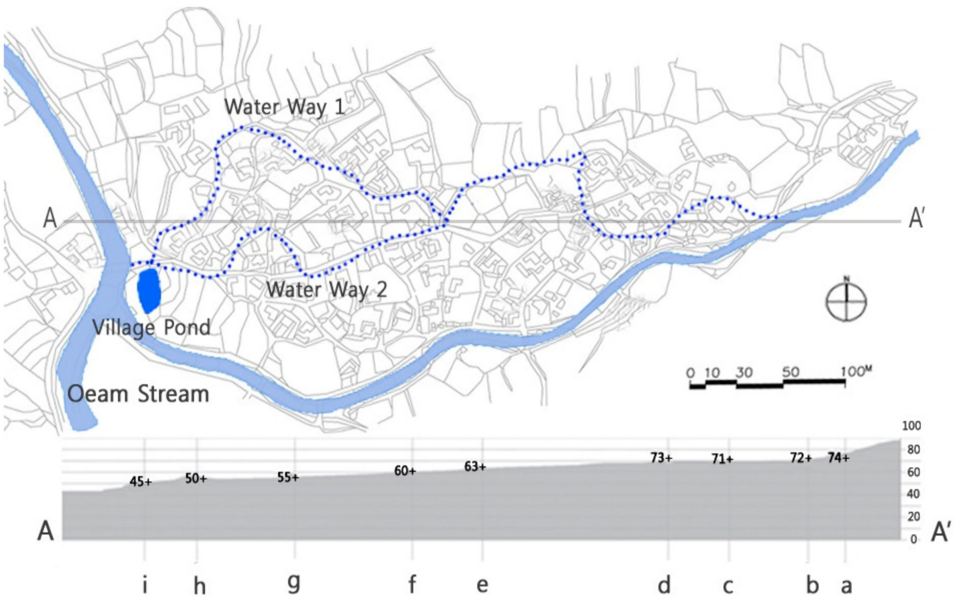

Figure 3. Present state of Oeam Village's waterway.

Village Pond

There are two types of ponds inside Oeam Village. The first type is a pond outside a personal residence that is part of a garden; the second type is built in a public space and functions as a water storage facility.

This research addresses the latter type of pond. Following modernization, domestic sewage ducts were reclaimed as pipes and connected to a sewage treatment facility. When the pollution levels of domestic sewage were low, domestic sewage and effluent storm water from a home would be temporarily detained and reused. A typical example of this is the small village pond next to what is referred to by the villagers as the Professor's House. The distinct shape of the waterway connected to the village pond from the wall of the Professor's House remains today. After collecting in a pool that spanned over 200 cm^2, the water would be reused for agriculture. Any water that was trapped after surpassing a certain level would flow back into the village waterway [3].

Influent water from the village pond next to the Professor's House was separated into domestic sewage that flowed from the Professor's House and a water supply that flowed from farmland. Influent water that ran down from farmland above the village pond would pass through terraced fields and enter the village pond at the lowest point. According to an interview with a village resident (an 80-year-old grandmother), the pond used to be twice the size it is now, and its water was utilized during water shortage periods. The village pond today is nearly incapable of performing its function as a source of agricultural water. Influent water that flows from farmland creates wetlands, and the large colonies of willows and aquatic plants present keep the water comparatively clean.

Another village pond was constructed by digging out a one-block section in the form of a bangjuk at the lowest point of the field and directing water into it from the waterways (see Table 1). All of the effluent rain water from farmland located on the right side of the village entrance flows into the pond. There are plans to connect the waterway to direct effluent that flows down from the village to the pond.

Figure 4 shows the pond that the Oeam Village Conservation Association decided to build in 2013 for the purposes of treating non-point pollutant sources such as nitrogen and phosphorus emitted from the village farmland and providing a new tourist attraction for visitors to the village (interview with village conservation chairman, Lee Joonbong, 2014). The village pond (see Figure 5) created by the Oeam Village Conservation Association is not a historical restoration or reproduction. Rather, it takes the form of a village bangjuk, as commonly seen in traditional Korean villages. One block of farmland in front of the village was converted into this pond to promote the environmental ecological value of the traditional village.

This village water treatment structure should be considered an ecological watershed management treatment facility and studied as an environmentally friendly facility [9]. Its environmental ecological value is directly connected to the village pond, which temporarily stores effluent water from the village, reduces environmental pollution, increases species diversity, and provides a system for recycling water resources.

Figure 4. Oeam Village Pond, created in 2013, is absent from the 2012 satellite photo on the left but appears in the 2014 satellite photo on the right.

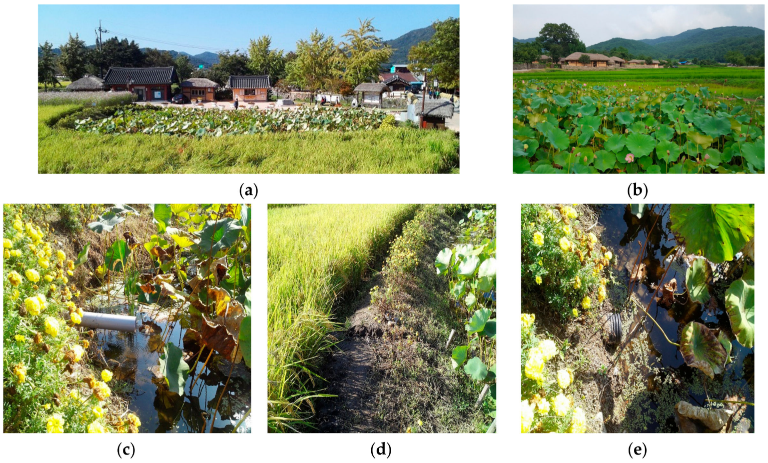

Figure 5. Influent point and effluent point of the village pond ((**a**): village entrance and village pond, the latter built at the lowest point of the field; (**b**): lotuses planted in the village pond and upper section of the field; (**c**): flow from the field into the pond; (**d**): inflow from the edge of the field; (**e**): drainage from the village pond into the waterway).

2.3.2. Village Pond Water Quality Inspection

The physical characteristics of the village pond located at the entrance to the village are summarized in Table 1. The pond, which is ovoid in shape, has an area of approximately 510 m^2 and a depth of less than 1.0 m. The top section of the pond abuts farmland, and the pond's left side abuts the village road and village waterway. This structure enables water in the pond to flow from the farmland and out of the village waterway (see Figure 3).

Table 1. Village pond physical data.

Type	Detailed Information	
	Main Items	Specifications
Wetland	Water Area	510 m^2
	Mean Water Depth	0.75 m
	Pond Circumference	86 m
	Water Volume	250–300 m^3
	Construction Date	2013
	Agricultural Land Area	11,493 m^2

Water quality inspections of the village pond took place in July, August, and October of 2016 and May, June of 2017, and specimens were collected from the pond's influent and effluent points. The influent point specimens were tested ten times, and the effluent point specimens were tested three times.

The point at which water flows into the village pond is divided into two sections where water flows down from farmland. One point connects to the village waterway, and the other is a point at which water flows down from the center of the farmland. The village pond's outflow point connects the village pond to the village waterway (see Figure 5).

As has been done in previous studies [19,30], the six measures of cistern water quality pollution considered in this research were T-N (total nitrogen), DO (dissolved oxygen), BOD (biochemical oxygen demand), COD (chemical oxygen demand), SS (suspended solids), and T-P (total phosphorus). The water quality analyses were conducted by the Korea Water Resource Corporation's Center for Tap Water Analysis. The results shown in Table 2 were obtained three weeks after the date of commission.

Table 2. Water quality values by item.

Point of Investigation	Analysis Items						Date
	T-N (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	SS (mg/L)	T-P (mg/L)	
Influent 1	3.990	3.8	11.4	22.7	216.0	3.130	July 2016
Influent 2	6.570	2.1	12.8	26.3	173.3	2.220	
Effluent	0.660	7.7	4.2	11.3	105.3	0.116	
Influent 1	1.065	7.8	4.0	9.8	51.0	0.618	August 2016
Influent 2	3.200	8.2	5.2	11.0	13.0	0.652	
Effluent	0.562	8.4	1.9	5.5	17.0	0.491	
Influent 1	1.047	7.3	4.1	9.0	548.0	0.168	January 2016
Influent 2	2.791	6.2	7.3	14.1	1685.0	0.413	
Effluent	1.001	8.6	2.7	5.9	253.0	0.043	
Influent 1	10.320	7.1	10.4	56.0	130.0	0.566	May 2017
Influent 2	6.912	7.1	17.3	44.7	95.0	0.624	
Effluent	2.640	9.1	5.9	21.7	11.2	0.110	
Influent 1	11.952	7.6	18.7	43.3	168.0	1.094	June 2017
Influent 2	10.944	7.1	28.3	59.6	74.0	1.334	
Effluent	2.388	8	5.9	16.2	21.3	0.384	

3. Results

3.1. Analysis of Water Purification

The influent-point and effluent-point water quality of the village pond were analyzed to assess the water treatment efficiency of the pond. The analysis was conducted by evaluating the rate of change (reduction rate) of each water quality measure considered. The rate of change in water quality for each item was calculated using the formula below:

$$\text{Removal Efficiency, \%} = [(\text{influent concentration, mg/L}) - (\text{effluent concentration, mg/L})] \div (\text{influent concentration, mg/L}) \times 100. \quad (1)$$

The removal efficiency results are summarized in Table 3.

Table 3. Removal efficiency.

	Influent Average	Effluent Average	Removal Efficiency (%)
T-N	5.879	1.450	75.33
DO	6.430	8.360	−30.02
BOD	11.950	4.120	65.52
COD	29.650	12.120	59.12
SS	315.330	81.560	74.14
T-P	1.082	0.229	78.85

The calculated water quality rates of change (reduction rates) for the water quality measures considered are illustrated in Figure 6.

Statistical analyses were conducted using SPSS for Windows (Ver. 24.0, SPSS, Inc., Chicago, IL, USA) to assess the significance of the rates of change (reduction rates) obtained. Paired *t*-tests were conducted to assess whether significant differences existed between the means of the water quality measures considered for the influent-point and effluent-point water samples. Sample statistics for each of the water quality measures are shown in Table 4, and sample correlation coefficients are shown in Table 5. The results of the paired *t*-tests are shown in Table 6.

Table 4. Sample statistics for influent and effluent water quality parameters.

		Ave	N	SD	Standard Error of the Mean
Alternative 1	Influent T-N	5.879	10	4.091	1.294
	Effluent T-N	1.450	10	0.932	0.295
Alternative 2	Influent DO	6.430	10	1.949	0.616
	Effluent DO	8.360	10	0.510	0.161
Alternative 3	Influent BOD	11.950	10	7.724	2.443
	Effluent BOD	4.120	10	1.718	0.543
Alternative 4	Influent COD	29.650	10	19.646	6.213
	Effluent COD	12.120	10	6.525	2.063
Alternative 5	Influent SS	315.330	10	503.795	159.314
	Effluent SS	81.560	10	97.417	30.806
Alternative 6	Influent T-P	1.082	10	0.926	0.293
	Effluent T-P	0.229	10	0.185	0.059

SD = standard deviation, Ave = average.

Table 5. Sample correlation coefficients for influent and effluent water quality parameters.

		N	Correlation	*p*-Value
Alternative 1	Influent TN–Effluent TN	10	0.819	0.004
Alternative 2	Influent DO–Effluent DO	10	0.581	0.078
Alternative 3	Influent BOD–Effluent BOD	10	0.823	0.003
Alternative 4	Influent COD–Effluent COD	10	0.921	0
Alternative 5	Influent SS–Effluent SS	10	0.809	0.005
Alternative 6	Influent TP–Effluent TP	10	−0.093	0.799

Table 6. Paired *t*-test results for influent and effluent water quality parameters.

		Ave	SD	Average Standard Error	95% Confidence Interval		*t*	Df	*p*-Value
					Lower Limit	Upper Limit			
Alternative 1	Influent TN–Effluent TN	4.429	3.370	1.066	2.018	6.839	4.156	9	0.002
Alternative 2	Influent DO–Effluent DO	−1.930	1.704	0.539	−3.149	−0.711	−3.581	9	0.006
Alternative 3	Influent BOD–Effluent BOD	7.830	6.385	2.019	3.262	12.398	3.878	9	0.004
Alternative 4	Influent COD–Effluent COD	17.530	13.868	4.386	7.609	27.451	3.997	9	0.003
Alternative 5	Influent SS–Effluent SS	233.770	428.777	135.591	−72.959	540.499	1.724	9	0.119
Alternative 6	Influent TP–Effluent TP	0.853	0.961	0.304	0.166	1.540	2.808	9	0.02

Df = Degrees of freedom.

Figure 6. Rates of change (reduction rates) of water quality parameters ((**a**) total nitrogen, (**b**) dissolved oxygen, (**c**) biochemical oxygen demand, (**d**) chemical oxygen demand, (**e**) suspended solids, (**f**) total phosphorus).

3.2. Changes in Ecological Resources

The target research area functioned as an area for food production before the village pond was constructed in 2013. The surrounding farmland area is 11,493 m^2. A one-block area (510 m^2) of the farmland was transformed for use as a village pond. Single-species gramineous plants grew wild in the field before the transformation. However, ecological diversity resulted from the village pond's construction. The dominant vegetation observed in the target area was the lotus (*Nelumbo nucifera*) which had a distribution area of 510 m^2. Duckweed (*Lemna perpusilla* Torr.), brown silvertop grass (*Persicaria thunbergii* H. Gross), water pepper (*Persicaria hydropiper* (L.) Spach), Singhara nut (*Trapa japonica* Flerov.), bog pondweed (*Potamogeton distinctus* A. Benn.), shaggy arundinella reed (*Arundinella hirta* (Thunb.) Tanaka), and barnyard millet (*Echinochloa crus-galli* var. frumentacea) were also observable with the naked eye (see Figures 7 and 8).

Figure 7. *Lemna perpusilla, Arundinella hirta*.

Figure 8. *Nelumbo nucifera, Trapa japonica*.

Aquatic plants are the primary producers of everglades ecosystems, which stabilize wetland soil and prevent erosion. Aquatic plants also absorb materials suspended at the water level, including nutrient salts and toxic substances. Aquatic plants absorb nutrient salts quickly, have short storage periods, have high reuse values, and can be used in water treatment systems that utilize aquatic plants [31].

In the case of lotuses, the results of this study were similar to those of other research that has shown a high rate of efficiency in nutrient salt removal for lotus plants in large eco-wetlands [32] and the results of thesis research that demonstrated the marked ability of lotuses to remove organic matter from wetlands [33]. Oeam Village is one of Korea's representative traditional villages, and numerous tourists visit the village yearly. The village has also applied to register with UNESCO as a world heritage site. The village conservation association appears to have chosen to emphasize landscape and ecological value over crop production value. The village pond was constructed in the form of a typical village bangjuk as a means of water treatment and to provide a new tourism attraction, in addition to improving the landscape and ecological value of the village.

4. Discussion

As shown in Table 3, the measurement results demonstrated that the variation rates in water quality for each item were 75.33 percent for TN, 65.52 percent for BOD, 59.12 percent for COD, 74.14 percent for SS, and 78.85 percent for TP. An increase of 30.02 percent was observed for DO.

The water that flows into the village pond from the farmland stays for some time in the village ponds, where it is purified through filtration, adsorption, and denitrification of pollutants. Although results may vary depending on the survey purpose, survey timing, and season, the water purification function has been confirmed in a similar test for general detention ponds. In addition, as shown in Table 6, TN, DO, BOD, and TP COD exhibited significant differences between water quality at the outflow point and at the inflow point. However, the differences were non-significant for SS.

The significant purification results should be understood in certain contexts, however. The water quality survey was conducted in May, June, July and August, when the highest crop growth was expected, and in October, when the growth was completed, to negotiate the timing of the application of fertilizer to farmland adjacent to the village pond—an assumed source of water pollution. It has been four years since the pond was built at the entry to Oeam Village, and it is in the process of stabilization. A statistical analysis based on a continuous water-quality survey will provide more reliable knowledge of whether the water treatment efficiency for each item is significant.

This study aimed to showcase the ecological diversity that has been achieved through ecological purification and various vegetation changes in the village ponds in Oeam Village. It was confirmed that water treatment was achieved by the ecological system of the ponds in the traditional village—distinct from potential alternatives such as mechanical devices. It was also confirmed that changes in vegetation had occurred after the village ponds were created. These elements are considered beneficial for improving the environmental-ecological values of traditional villages.

5. Conclusions

The pond at the village entrance, which was the focus of this study, takes the form of a village bangjuk, commonly seen in traditional Korean villages. It also reduces non-point pollution sources that flow in from farmlands in the upper portion of the village. The treatment efficiencies of TN, DO, BOD, COD and TP were 75.33, 30.02, 65.52, 59.12 and 78.85 percent, respectively, and were all found to be statistically significant except SS. The village pond acts as an environmental filter for pollution sources that arise in the farmland outside of the village.

The analysis of changes in plant species surrounding the village pond identified nine types of single-species gramineous plants that were cultivated in the farmland. The surrounding plants exhibit healthy growth and the water purification function of the lotus plants in particular support the environmental ecology of the village pond. This has a positive impact on visitors to the village and thus improves the ecological value and tourism appeal of the village.

The study results confirm that the village pond temporarily stores effluent water from the village from farmland in particular and reduces the pollutant load in the river outside the village. The results also confirm that plant species changes have occurred that have increased the area's ecological soundness.

The results of this study will contribute to increasing the ecological soundness of traditional Korean villages, providing eco-tourism resources for visitors to traditional villages, and the application of the principles of spatial composition to future eco-friendly villages. Further research must be carried out on these topics.

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