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Research Article

Optimizing the amount of concrete for the construction of wastewater stabilization ponds: A case study of Ayvadere, Trabzon, Türkiye

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ABSTRACT

Natural systems are a cost-effective way to clean wastewater from small communities. This paper aims to use an optimization technique to minimize the volume of concrete needed to construct a facultative pond provided within a series of three ponds. A nonlinear constrained optimization model was written and then solved using one of the Add-Ins of MS office. The add-in used was Excel Solver, and the algorithm was generalized reduced gradient (GRG). Before applying the optimization model, wastewater stabilization ponds (WSPs) were designed using various configurations and arrangements. The best possible configuration that gave minimum area and hydraulic detention time was selected for the study area. Afterward, the optimization model was applied that further reduced the area by 11.46%, hydraulic detention time by 11.47%, and concrete volume by 6.94% compared to the traditional approach. In both methods, effluents satisfy the Turkish class-B standards for irrigation. It is recommended that a small-scale application of the model be made to compare the results before applying it on a large scale.

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INTRODUCTION

Wastewater treatment helps improve aquatic ecosystems' health and reduces contamination of natural water bodies. Treating wastewater minimizes the pollution of water bodies and improves the health of aquatic ecosystems. Natural methods for wastewater treatment, such as wastewater stabilization ponds (WSPs) and constructed wetlands, are promising techniques for treating wastewater in decentralized communities [1].

Natural wastewater treatment systems, like (WSPs), have many advantages over traditional methods, such as similar treatment performance. The use of renewable energy helps to reduce operating costs. Minimal involvement of mechanical parts helps in long-term operation without needing repair and maintenance. Due to their primary reliance on nature, there is no need to employ qualified personnel for construction, operation, and maintenance, hence decreasing the overall cost. The wastewater treatment based on natural processes may also provide indirect benefits,

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such as making that part of the land look better, making a home for wildlife, or giving people a chance for recreational and educational activities. Also, their effluent can be used to irrigate various crops. The problem with natural systems is that they need a large area which increases their construction cost [2]. So, there is a need to explore ways to reduce the overall cost of natural wastewater treatment systems. This study sought to reduce the cost of building a facultative pond provided within a series of three ponds.

When it comes to the construction of wastewater treatment plants, wide-ranging materials, like concrete, steel, gravel, sand, soil, and other similar materials are used to build wastewater treatment plants (WWTPs) [3, 4]. Additionally, wastewater treatment is based on several processes that require chemicals, electricity, and air. There are also byproducts of treatment, such as sludge, carbon dioxide (CO_2), and methane (CH_4) [5]. WSPs have several types, such as aerobic, anaerobic, facultative, and maturation ponds. They have different flow conditions: complete mix, dispersed, and plug flow [6]. As WSPs are based on natural systems for wastewater treatment, minimizing the overall area required to construct the treatment plant is necessary. This area reduction will help reduce the needed concrete volume for WSPs [2].

According to Goodarzi et al. [7], baffle walls (BWs) in pond systems improve flow conditions, eliminate dead spots, and enhance pollution removal efficiency. So far, there have been studies about stabilization pond systems, including different numbers and lengths of BWs. Li et al. [8] have discussed the effect of various lengths, numbers, and spacing between BWs. He has also discussed the works of multiple authors who worked on the effect of BWs. Goodarzi et al. [7] discussed that the BWs increase the efficiency of the hydraulic system in WSPs. Their addition helps the piston flow and, therefore, increases the efficiency of wastewater treatment. This research also examines how BWs reduce the acreage and concrete needed to build a facultative pond. One of the Add-Ins for MS excel is used to ensure the facultative pond is built in the best way possible. The system uses the generalized reduced gradient algorithm (GRG) to run the analysis [9]. The program inspects and adjusts variables until constraints are met [10].

This research optimized the concrete volume needed to build a facultative pond provided between anaerobic and maturation ponds. Following were the goals of this study: (a) Design of WSPs with the traditional method, including various numbers and lengths of baffles, to select the best configuration for the study area. (b) Optimize the design using the GRG algorithm. Three decision variables were optimized: hydraulic detention time, number, and length of baffles. (c) Design facultative ponds by applying the results of an optimization model. (d) Compare the results and determine the reduction in the volume of concrete. The design of WSPs involves the meteorological parameters of the pond area, which is in the Ayvadere village of Arakli city in Trabzon province of Türkiye.

MATERIALS AND METHODS

Acronyms and Abbreviations

MPN, Most probable number; LPCD, Liter per capita per day; N_{BW}, Number of baffle walls; L_{BW}, Length of baffle walls; BWs, Baffle walls; WSPs, Wastewater Stabilization Ponds; APs, Anaerobic Ponds; FP, Facultative Pond; MP, Maturation Pond; D_T, Detention time; O_L, Organic load; Q_i, Inflow of the wastewater stabilization ponds (m^3/d); Q_e, Outflow from the wastewater stabilization ponds (m^3/d); $(BOD_5)_i$, Concentration of 5 days influent biochemical oxygen demand (mg/l); $(BOD_5)_e$, Concentration of 5 days effluent biochemical oxygen demand (mg/l); T_{avg}, Region's coldest average monthly air temperature (°C); V_p, Pond volume (m^3); d_p, Pond depth (m); t; Thickness of concrete slab and walls; A_p, Area of the pond (m^2); Kt, Overall decay constant (d^{-1}); K_b, Bacterial decay constant (d^{-1}); K_f, BOD_5 decay constant at the average temperature of the coldest month in the region (d^{-1}); N, Population (Number of persons); N_i (MPN/100 mL), Influent Fecal coliform; N_f/N_o (MPN/100 mL), Effluent fecal coliform; N_e (MPN/100 mL), Effluent fecal coliform; X, Ratio between length and width; W_{avg}, Average width of the pond (m); L_{avg}, Average length of the pond (m); L_{top}, Length from top of the pond (m); W_{top}, Width from top of the pond (m); A_{top}, Area from top of the pond (m^2); A_f, Area of the facultative pond (m^2); d_f, Dispersion factor; a, Dimensionless constant; λ_v, Volumetric load (g/m^3/d); λ_s, Surface loading (kg/ha.d).

Marais method was followed for the design of anaerobic ponds. The facultative and maturation ponds were designed based on the Yanez method for the dispersed flow. Martinez et al. [11] have summarized the design steps of these ponds. The design of WSPs involved in this manuscript followed the same steps. There were three configurations analyzed in this study: (i). Configuration 1: Anaerobic, facultative, and maturation ponds. (ii). Configuration 2: Facultative and maturation ponds. (iii). Only facultative pond. The changes made to the design calculations based on meteorological conditions of the study area are mentioned below.

Anaerobic Pond

a. Volumetric $\left(\frac{g.\ BOD_5}{m^3.d}\right) = \lambda_v = 100$ (1)

b. BOD_5 removal (%) = 40 (2)

Facultative and Maturation Ponds

c. The maximum surface loading rate of biochemical oxygen demand (BOD_5) is calculated using the equation below.

$$\lambda s \left(\frac{kg}{ha.d}\right) = 350 \times \left(1.107 - 0.002 \times T_{avg}\right)^{T_{avg} - 25} \quad (3)$$

The equation incorporates safety factors to give a design equation for FPs that can be used globally [12].

d. The coefficient of bacterial reduction was also different. First, $(K_b)_{20}$ was calculated based on the depth of FPs and MPs. Then $(K_b)_{T_{avg}}$ was calculated based on the last ten years' average temperature during the coldest month of the study area.

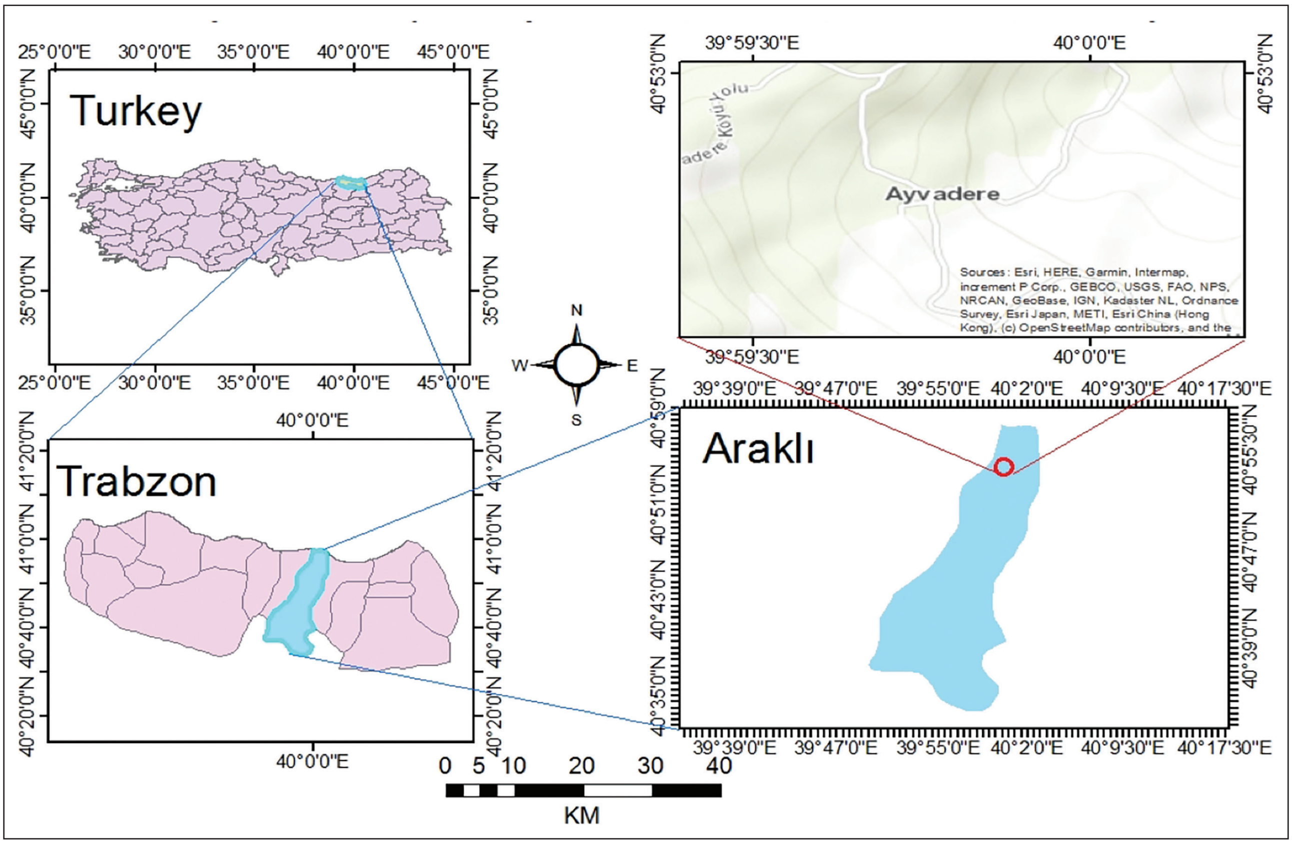

Figure 1. Study area map of Ayvadere, Araklı, Trabzon, Türkiye.

$$(k_b)_{T_{avg}} = (k_b)_{20} \times \theta^{\,T_{avg}-25} \quad (4)$$

Where: $(k_b)_{20}$= 0.542 x $H^{-1.259}$, and the value of θ was taken constant; Marais 1974 used 1.19. However, Yanez 1993 mentioned that the value is overestimated and must be taken as 1.07 [13].

Note: To meet the Turkish design standards for WSPs, manual adjustment was made to the hydraulic detention time of facultative ponds, as it is done in the design procedure of the maturation ponds.

Optimization Model

The Excel solver performed the concrete volume optimization for the facultative pond, which employed a GRG algorithm. As the objective function, the volume (V_{conc}) is written in terms of concrete required for the slab, parameter walls, and BWs of the facultative pond. The mathematical relationships explored for the design optimization are listed below. The hypothesis is to maintain the mathematical link between detention time, length, and the number of BWs in the model. The design and or decision variables represent the hydraulic detention time (D_T), number (N_{BW}), and length of BWs (L_{BW}). The dimensions of the base slab, parameter walls, and BWs are written in terms of these variables in equations 12 and 13. The equation 13 was used as the objective function in this optimization model.

Minimize concrete volume for the facultative pond =V=

Concrete volume for the base slab $((L\times W)\times t)+$

Concrete volume for the parameter walls $((2\times L\times d_p+2\times W\times d_p)\times t)+$

Concrete volume for BWs (%age length of the BWs×((L× Number of BWs × d_p)×t) (5)

The walls and floor slab thicknesses were considered equal (t=15 cm). For simplification, t was taken as common, and the equation was modified as given below.

$$Min.V = \left[(L\times W) + (2\times L\times d_p + 2\times W\times d_p) + \left(\left(\frac{L_{BW}}{L}\times 100\right)\times N_{BW}\times d_p\right)\right]\times t \quad (6)$$

Following are the steps that were taken to represent the dimensions in terms of design variables.

Average hydraulic detention time:

$$D_T = \frac{V_p}{Q_i} \quad (7)$$

$$V_p = A_p \times d_p \quad (8)$$

If the length-to-width ratio is 3, then the length and width of the facultative pond can be calculated as mentioned below.

$$L = 3\times B \quad (9)$$

Depth of the parameter walls and BWs was equivalent and represented as: (d_p)=1.5 m.

Table 1. Design calculations using traditional methodology

Pond	N	LPCD	T_{avg} °C	$(BOD_5)_i$	N_i	d_p
Anaerobic	1200	179	8.9	200	10000000	4
Facultative			8.9	120	5717492	1.5
Maturation			8.9	19	11104	1
Q_i	O_L	% Removal of BOD_5	λ_v	λ_s	V_p (m^3)	A_p (m^2)
214.80	42.96	40	100		429.60	107
214.18	25.70	87.49		88	10494.68	6996
173.60		67.99			3472	3472
DT	$(BOD_5)_e$	$(BOD_5)_e$ corrected by evaporation	Qe	BW Length (% × L)	X	d_f
2.00	120	120	214.18			
49.00	15	19	173.60	0.5	38	0.0261
20	5	5	153.46	0.5	19	0.0524
71.00						
a	K_t	K_f	N_e	N_e corrected by evaporation	BWs	L-W ratio
	0.3771		5700912	5717492		2
1.34	0.1534	0.14271	9000	11104	4	3
1.44	0.2558	0.14271	162	183	4	
W_{avg}	L_{avg}	W_{top}	L_{top}			A_{top}
7.33	14.66	7.33	14.66			107
48.29	144.88	48.29	144.88			6996
48.29	71.89	48.29	71.89			3472
The total area of WSPs with traditional methodology (m^2)			10576			
Concrete volume for the facultative pond with traditional methodology (m^3)						1201.59

$$B = \sqrt{\frac{D_T \times Q_i}{3 \times d_p}} \tag{10}$$

$$L = 3 \text{ x } \sqrt{\frac{D_T \times Q_i}{3 \times d_p}} \tag{11}$$

The equation 6 was modified as given below by substituting the length (L) and width of the pond.

$$\text{Min. V} = \left[\left(3 \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}} \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right) + \left(\left(2 \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right) + 3 \times \left(2 \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right)\right) \times d_p + 3 \times d_p \times N_{BW} \times L_{BW} \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right] \times t \tag{12}$$

By following the square root multiplication rules and multiplying the other terms involved, equation 12 can be further simplified as below:

$$\text{Min. V} = \left[\left(3 \times \frac{D_T \times Q_i}{3 \times d_p}\right) + \left(8 \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right) \times d_p + 3 \times d_p \times N_{BW} \times L_{BW} \times \sqrt{\frac{D_T \times Q_i}{3 \times d_p}}\right] \times t \tag{13}$$

It is essential here to notice and keep in mind that the design flow is not a decision variable. Instead, it is used to design the pond based on the project's population. The design and optimization constraints are given below.

BOD_5	≤	30 mg/l,		
Fecal coliform	≤	200 MPN/100mL,		
N_{BW}	≤	10,		
N_{BW}	=	Integer,		
30	≤	D_T	≤	50 days,
0.5	≤	L_{BW}	≤	0.9,
N_{BW}, D_T, and d_f	>	0.		

Application of the Model

Ayvadere is a neighborhood in Arakli, Trabzon, Türkiye (Fig. 1). A facultative pond was designed for this neighborhood provided in configuration 1. The number of residents in the study area was calculated by considering 20 years design period were, 950; the rate of water supply taken was, 179 (LPCD), wastewater generation rate was considered 80% of the water supplied; design flow in m^3/day (Q_i)=214.8 [14]. The average temperature of the study area's coldest month calculated from the last ten years' meteorological data was 8.9 °C. The evaporation rate was also calculated from the last ten years' metrological data, which was 5.8 mm/day. The influent BOD_5 concentration was 200 mg/L, and the concentration of fecal coliforms was 10^7 MPN/100 mL. These are the typical values for wastewater generated from a domestic source [15].

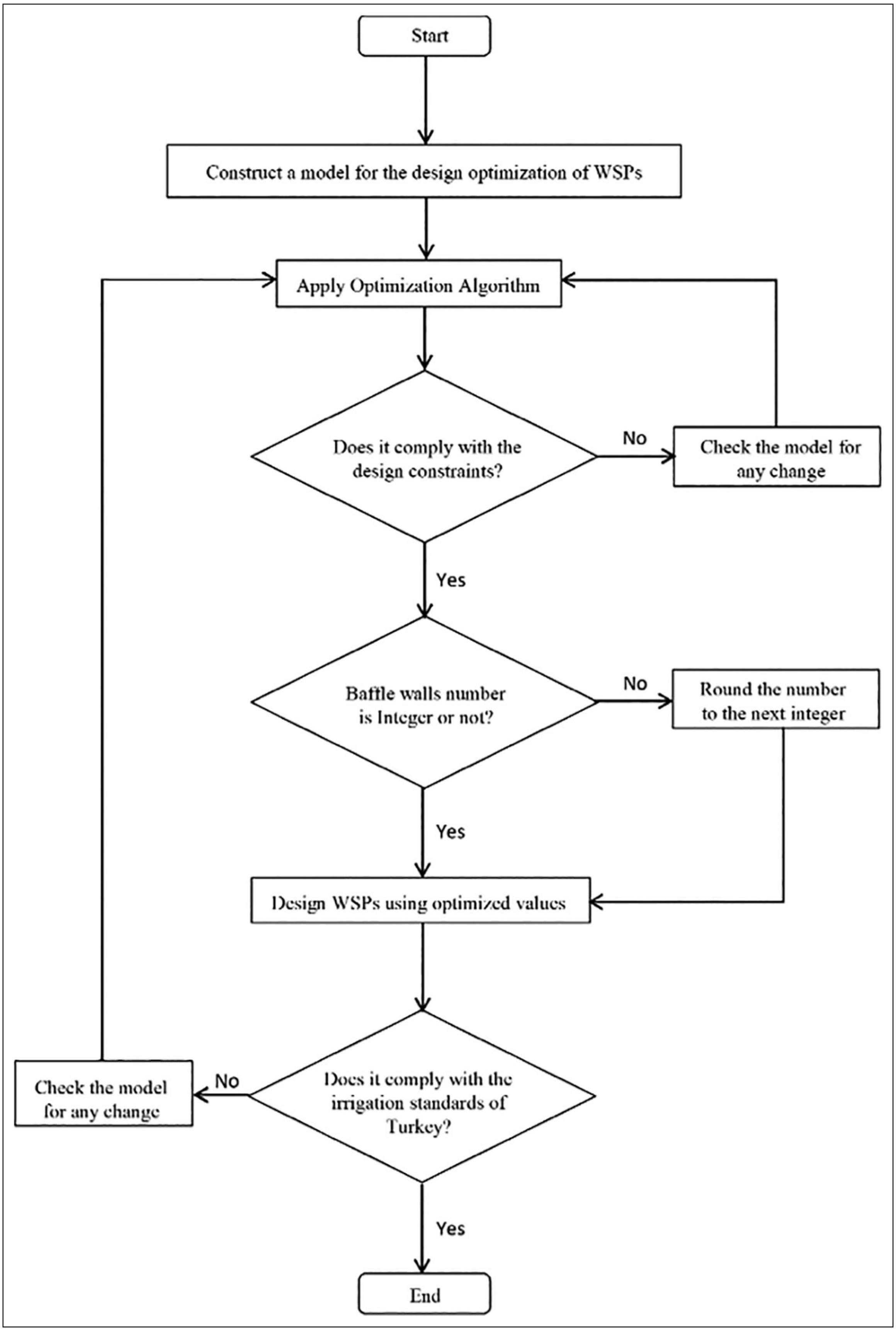

Figure 2. Flowchart of the optimization model.

Table 2. Design calculations using optimization results of the optimization model

Pond	N	LPCD	T_{avg} °C	$(BOD_5)_i$	N_i	d_p
Anaerobic	1200	179	8.9	200	10000000	4
Facultative			8.9	430	5717492	1.5
Maturation			8.9	6194	13185	1
Q_i	O_L	% Removal of BOD_5	λ_v	λ_s	Vp (m^3)	Ap (m^2)
214.80	42.96	40	100		429.60	107
2.00	25.70	86.09		88	9290.90	6194
43.38		68.83			3565	3565
D_T	$(BOD_5)_e$	$(BOD_5)_e$ corrected by evaporation	Q_e	BW Length (% × L)	X	d_f
2.00	120	120	214.18			
43.38	17	20	178.25	0.5	96	0.0103
20	5	6	157.57	0.5	22	0.0452
65.38						
a	K_t	K_f	N_e	N_e corrected by evaporation	BWs	L-W ratio
	0.3771		5700912	5717492		2
1.13	0.1534	0.14271	10973	13185	7	3
1.39	0.2558	0.14271	177	200	4	
W_{avg}	L_{avg}	W_{top}	L_{top}			A_{top}
7.33	14.66	7.33	14.66			107
45.44	136.32	45.44	136.32			6194
45.44	78.46	45.44	78.46			3565
The total area of WSPs with traditional methodology (m^2)			9866			
Concrete volume for the facultative pond with optimization model (m^3)						1118.23

The class-B Irrigation Standards of Türkiye were considered to determine the suitability of the effluents. According to the standards, effluent BOD_5 must be less than 30 mg/L, whereas fecal coliforms concentration must be less than 200 MPN/100 mL. As mentioned above in the design constraints, the maximum number of BWs for the design of the facultative pond was 10, and their length varied between 50 to 90 percent of the total calculated length of the pond. Moreover, it was ensured in the optimization model that N_{BW}, D_T, and d_f are greater than zero, and the BWs are integer. The maximum and minimum D_T in the Turkish design standards for a facultative pond ranged between 30–50 days [16]. Figure 2 shows the flowchart for the functioning of the optimization model.

RESULTS AND DISCUSSION

Results

Appendix B summarizes the results of 60 analyses performed to select the best configuration for the study area. Generally, it is observed that adding BWs reduces the design area and D_T needed. Moreover, it is also observed that an increase in the length of the BWs also decreases the total area and D_T of FP. The effluents of configurations 1 and 2 comply with Turkish irrigation water pollution regulations [16]. Configuration 3 had the lowest area; however effluents did not meet BOD_5 and fecal coliform standards in this investigation. It confirms that the WSPs effluent cannot be utilized for unrestricted irrigation until MPs are provided [13]. Compared with configuration 2, configuration 1 needs less area for constructing WSPs. Due to this reason, configuration 1 is selected to apply the optimization model.

Table 1 shows the design calculation of configuration 1 using traditional methodology. Moreover, it shows the overall area to be occupied i.e., 10576 m^2, and the concrete volume (1201.59 m^3) needed to construct the WSPs for Ayvadere village. Figure 3 shows the solver parameters window that includes the objective function cell set to minimization. Furthermore, it also shows the variable cells and the constraints applied to them. The algorithm that the solver follows can also be seen in Figure 3. The results window of the solver, shown in Figure 4, depicts that all constraints have been met. Figure 5 shows the report from the solver with the initial and end values. In addition, it illustrates the restrictions' satisfaction with values and the gap between them.

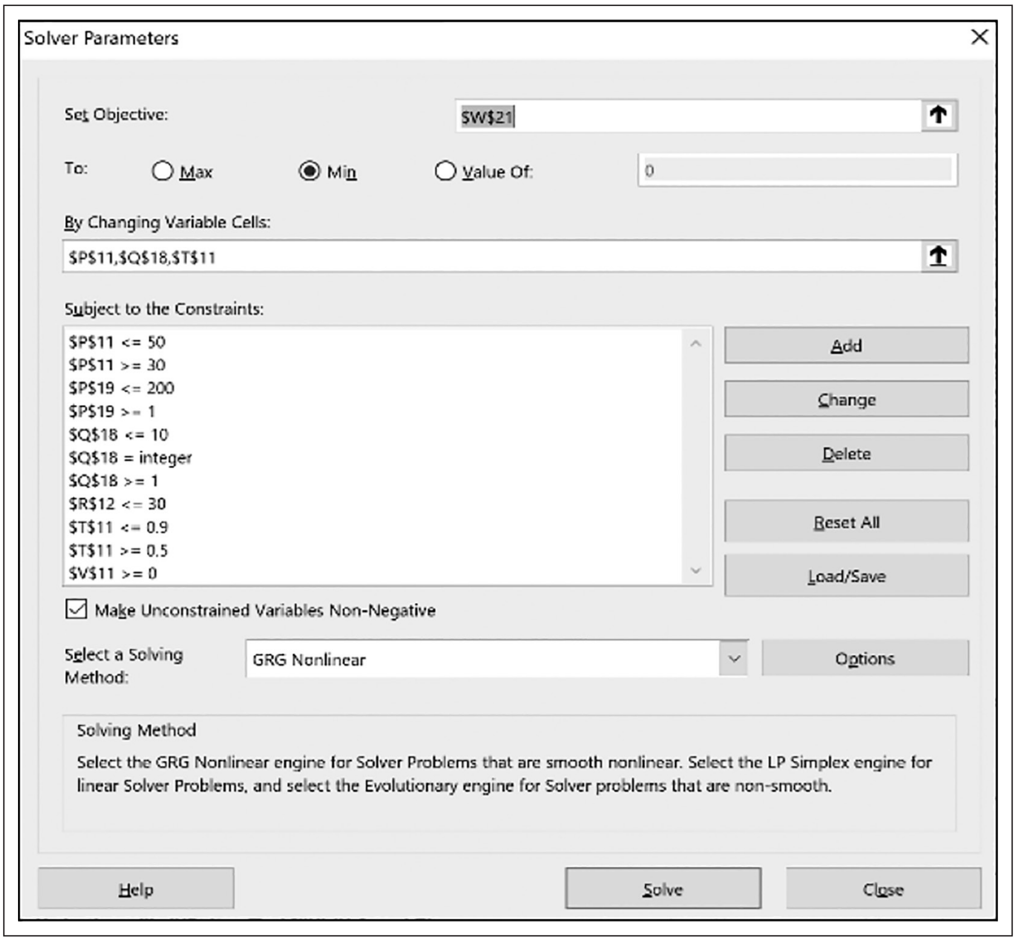

Figure 3. Optimization model application to the design of a facultative pond with Excel Solver.

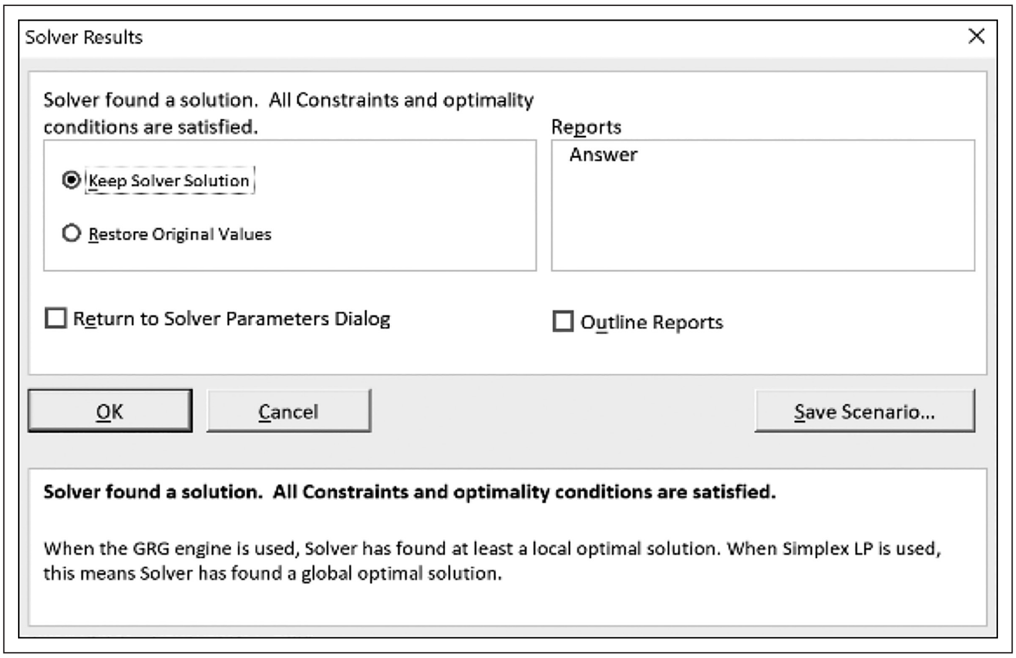

Figure 4. Excel Solver results dialogue box.

Microsoft Excel 16.0 Answer Report
Worksheet: [GRG Excel Solver.xlsx]Sheet1
Report Created: 6/28/2022 10:17:54 AM
Result: Solver found a solution. All Constraints and optimality conditions are satisfied.
Solver Engine
Solver Options

Objective Cell (Min)

Cell	Name	Original Value	Final Value
W21	Concrete volume with mathematical modeling Atop	1201.588574	1118.227495

Variable Cells

Cell	Name	Original Value	Final Value	Integer
P11	DT	49.00	43.38	Contin
Q18	BWs	4	7	Integer
T11	BW Length (% × L)	0.5	0.5	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
P19	Ne corrected by evaporation	200	P19<=200	Binding	0
P19	Ne corrected by evaporation	200	P19>=1	Not Binding	199
R12	(BOD5)e corrected by evaporation	6	R12<=30	Not Binding	24.11502268
V11	d	0.0103	V11>=0	Not Binding	0.0103
P11	DT	43.38	P11<=50	Not Binding	6.62046112
P11	DT	43.38	P11>=30	Not Binding	13.38
Q18	BWs	7	Q18<=10	Binding	0
Q18	BWs	7	Q18>=1	Not Binding	6
T11	BW Length (% × L)	0.5	T11<=0.9	Not Binding	0.4
T11	BW Length (% × L)	0.5	T11>=0.5	Binding	0
Q18=Integer					

Figure 5. Optimization report using Excel solver.

Table 3. Comparison of the results achieved with both approaches

Component	Traditional methodology	Optimization model	Reduction	%
D^T	49	43.38	5.62	11.47
N_{BW}	4	7	–	–
Area (m^2)	6996	6194	802	11.46
Concrete (m^3)	1201.59	1118.23	83.36	6.94

Table 2 shows the calculation of the design using the optimization model results. The area and concrete volume needed for WSPs are 9866 m^2 and 1118.23 m^3, respectively. Moreover, it shows how the results of the solver analysis system changed the values of the d_f, the dimensionless constant, from 0.0261 to 0.0103 the pond's width reduced (from 48.29 m to 45.44 m), and length reduced (from 144.88 m to 136.32 m), the concentration of BOD_5 in the effluent increased (from 5 mg/l to 6 mg/l). In the same way, the three variables, N_{BW} & L_{BW} and D_T, were optimized.

DISCUSSION

It is important to note that the optimization model found the three decision variables or the best variables that meet the constraints. Even though the parameters proposed for the right side of the constraints (D_T and N_{BW}) were higher than what the system solver produced, this is necessary. It is proposed because the solver system needs the upper limits to work. Therefore, it is wise to suggest much higher limits so that the system can find the best one, but they should still be localized within the range that the constraints consider. The system figured out that the best length for the BWs is 50% of the length of the pond. The result is consistent with Li et al. [8]. The author has also discussed other favorable measurements of BWs that can be provided in ponds.

Table 3 shows the original values and those found by the optimization model. The optimized D_T is 5.62 days less than that achieved with the traditional methodology; this reduction in percentage is 11.47%. According to the method, the dimensions of the pond depend on D_T and the influent concentration of the pollutants. Additionally, Table 3 shows that an area reduction of 802 square meters, or 11.46 percent, was achieved. Table 3 also presents that the concrete volume calculated with optimized values is 83.36-meter cube, or 6.94% percent less than that achieved with the traditional approach. As it has already been mentioned in the problem statement, the main problem with pond systems is that they need much land. The percentage reduction

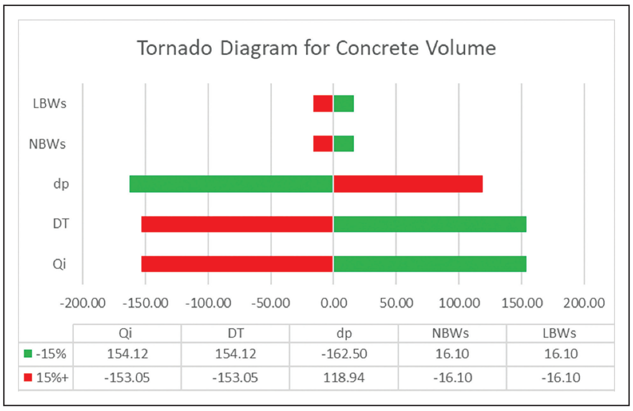

Figure 6. Sensitivity analysis for the total volume of concrete.

achieved through the optimization model is considerable.

The only higher value solver system found out is 7 BWs instead of the four that would have been chosen by the traditional design method. The higher number of baffles makes it easier to get rid of the fecal coliforms [17]. Philip et al. [18] listed several authors and their work on the impacts of baffles; all say that adding baffles to a pond improves hydraulic flow and makes it easier to get rid of pollutants. This paper's results agree with the second thing the authors said. Philip et al. [18] listed in their research that all of the authors did research on stabilization ponds with different number of BWs. They all came to the same conclusion: ponds with a larger number of BWs are more hydraulically efficient and better at treating wastewater biologically. The current study also backs up what the authors on the list have said.

Regarding getting rid of BOD_5 (Tables 1 and 2), the two analyses gave effluents that are below the class-B official Turkish standards for irrigation: 30 mg/L [16]. The removal efficiency of BOD_5, from facultative ponds, during the coldest month in the study area, was found to be 87.49 and 86.09 with traditional methodology and optimization model results, respectively. The removal efficiency is slightly higher than that of Gulsen et al. [19]. As it can be seen when the optimization model is used, the removal efficiency of BOD_5 is less, and there is more organic matter in the effluent, but it is still less than what is required by the standards.

Sensitivity Analysis

According to Anderson et al. [20], a tornado diagram can be used for sensitivity analysis. The research mentions that sensitivity analysis can be done by changing the values of the primary variables. The tornado diagram employs bars to describe sensitivity. The widest bar shows the most sensitive parameter on which the constraints rely. Figure 6 presents the sensitivity analysis for the volume of concrete. From the same figure it can be observed that two parameters, Q_i and D_T, are most sensitive and have an equivalent effect on the volume of concrete. The following sensitive parameter is the depth of the pond. It is interpreted that the volume of concrete is more when the depth of the pond is decreased, and it is less with an increase in depth. The number and length of the BWs are the least sensitive and have an equivalent effect on the objective function.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Optimization of the volume of concrete needed for the facultative pond provided within the series of three ponds was done. Even though this optimization model is used in this case study, it can be applied in other situations by changing inputs like temperature, BOD_5, fecal coliforms, evaporation, and depth of the pond. There were several ways to meet the Turkish design standards for the detention time of WSPs: addition of more BWs to the maturation pond, manual adjustment of detention time in the design of facultative pond, increased BOD_5 load, and decreased fecal coliforms load. From these three viable options available, two have been tried within the scope of this research (Appendix A).

Recommendations

It is suggested that this study be done on a small scale first so that the optimization results of the facultative pond can be validated. Moreover, variation in the number of baffle walls be studied for maturation ponds.

Appendix A Supplementary Data

The design calculations to select the best configuration for the Ayvadere village are available from the corresponding author on reasonable request.

ACKNOWLEDGEMENTS

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DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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Appendix B. Summary of the results with various configurations and arrangements

Sr. No.	Configuration	BW in FPs	Baffle wall Length									
			0.5		0.6		0.7		0.8		0.9	
			D_T (d)	Total area (m^2)	D_T (d)	Total area (m^2)	D_T (d)	Total area (m^2)	D_T (d)	Total area (m^2)	D_T (d)	Total area (m^2)
1	1	0	58.57	8622	58.12	8547	57.78	8490	57.53	8448	57.33	8415
2	2	0	70.49	9942	69.79	9830	69.30	9752	68.90	9688	68.58	9637
3	1	2	56.18	8223	55.50	8110	55.00	8027	54.63	7965	54.31	7912
4	2	2	65.67	9172	64.55	8993	63.70	8857	63.02	8749	62.48	8662
5	1	4	55.07	8038	54.52	7947	54.13	7882	53.82	7830	53.57	7788
6	3	4	33.92	4063	33.92	4063	33.92	4063	33.92	4063	33.92	4063
7	1	6	54.65	7968	54.17	7888	53.80	7827	53.55	7785	53.32	7747
8	2	6	62.00	8586	61.27	8469	60.74	8384	60.32	8317	60.00	8266
9	1	8	54.45	7935	54.00	7860	53.67	7805	53.42	7763	53.21	7728
10	2	8	61.49	8504	60.82	8397	60.36	8324	59.99	8265	59.70	8218
11	1	10	54.35	7918	53.92	7847	53.60	7793	53.35	7752	53.15	7718
12	3	10	33.92	4063	33.92	4063	33.92	4063	33.92	4063	33.92	4063