Research Article

Biodiversity in buffer zones: a study on the effect of richness versus evenness on maximizing p and n reduction in riparian buffer zones

Abstract

This study was done with the aim of evaluating the relation between flora biodiversity and efficiency of six buffer zones according to perimeter, area and width considerations.Six riparian buffer zones were selected andPerimeter, area, width, latitude and longitude were measured. Next, species compositions were investigated in each zone and then, biodiversity indices were calculated in 20×20 m^2 plots. In addition, soil samples were collected along 3 parallel transects from the beginning to the end of the farm and beginning to the end of six buffer zones at depth of 30 and analyzed for N and P concentrations. A two-way between-groups analysis of variance was conducted to explore the impact of biodiversity and the location of points on levels of N and P reduction.Results of this study showed that the difference between biodiversity indexes, which is primarily due to the diversity of species composition, influences the effectiveness of the "riparian buffer zones"(RBZ).

Keywords: evenness, nitrogen and phosphorus reduction, riparian buffer zone, species composition

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Goudarzian Pardis,[1] Yazdani Mohammad Reza,[1] Matinkhah Sayed Hamid[2]

[1]Department of desertification, Faculty of Desert studies, Semnan University, Iran
[2]Department of Natural Resources, Isfahan University of Technology, Iran

Correspondence: Dr Goudarzian Pardis, Department of desertification, Faculty of Desert studies, Semnan University, Semnan, Iran, Email p.goudarzan1986@gmail.com

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Introduction

The majority of rivers in most countries is isolated from agricultural fields by strips, commonly referred to as RBZ, and is comprised of narrow areas of natural plants.[1,2] They are considered as unique and dynamic systems[3] and act as an economically efficient way to reduce agricultural nonpoint source pollution.[4,5] Agricultural runoff is famous for the potential to transport sediment, nutrients and pesticides,[1] more specifically N and P, to surface water and can affect the environment.[6] Surface and ground water contamination by N and P from agricultural runoff is a crucial factor influencing water reservoirs all around the world.[7,8] P is known as the most vital nutrient-limiting factor with an ability to induce water pollution.[9] High concentrations of N in surface waters is also a cause of pollution, and in turn, results in instability of the ecosystem.[10] The effect of RBZ is of great satisfaction, with a reduction of 70– 98% for P and 70–95% for N.[11,12]

RBZ, as an interface between land and aquatic ecosystems, has high environmental gradients, ecological processes, and populations.[13] RBZ demonstrates a complex system of biodiversity, with high numbers of species bound to and interacting within the habitat.[14] They help create a framework for recognizing the biodiversity in flora. They play a role as habitat for resident flora as in other linear patches.[15] In these linear patches, plant species richness indices of ten changes significantly in space and time around stream margins, and these changes affect the biota and processes considerably[16] that effect efficiency of RBZ.

There are so many researches about RBZ from many aspects in the world,[11,17] however, studies about them are limited in Middle Eastern countries and despite the importance of biodiversity in the structure and efficiency of buffer zones, they have not been studied comprehensively. Local researches are necessary to gain information on buffer performance, with particular emphasis on biodiversity of buffers. Thus, this study was done with the aim of evaluating the relation between flora biodiversity and efficiency of six buffer zones according to perimeter, area and width considerations.

Materials and methods

Study area

ZayandehRud River Basin is one of the most crucial water bodies in the arid central Iran which has been persistently confronted by water stress in the course of the past 60 years. The ZayandehRud River Basin includes an area of about 26,917 km^2 in central Iran. The basin consists of six irrigation networks located mainly in the upper sub-basins that provide agriculture, the main water consumer, with water. Its major traditional crops are wheat, rice, barley, and corn, which are highly water consumptive. ZayandehRud River, with an average flow of 1400 million cubic meters (MCM) with 650 MCM of natural flow and 750 MCM of transferred flow, is the main surface water resource of the basin.[18] The river water has drinking, industrial, and agricultural usage. In its west–east journey, Zayandeh-Rood River runs through several agricultural fields.[18] The identification of pollutants throughout the river is vital and has a great impact on controlling the ecological circumstances of the basin. There are many riparian buffer zones along this river. Therefore, six riparian buffer zones were selected according to their differences, due to they are typical representatives of this area. (Figure 1).

Overall design

For the evaluation of relation between biodiversity and efficiency of buffering, six riparian buffer zones were selected around Zayandeh-Rood River. No artificial fertilization of the farm was done in these regions. One of these zones (first zone) had more complex species diversity than the other ones. First of all, perimeter, area, width, latitude and longitude of six buffer zones were measured along agricultural land around Zayanderud. Next, species compositions were investigated in each zone and then, biodiversity indices were calculated in 20×20m^2 plots. In addition, soil samples were collected along 3 parallel transects from the beginning to the end of the farm and beginning to the end of six buffer zones at same depth of 30 and analyzed in laboratory for N and P concentrations in length of 20 m.

All of distances in all zones were equal. Moreover, other factors such as soil type were same in all regions. The significance of different samples was tested by two ways between groups ANOVA. When results were shown to be significant, Tukey's multiple comparison tests were run.

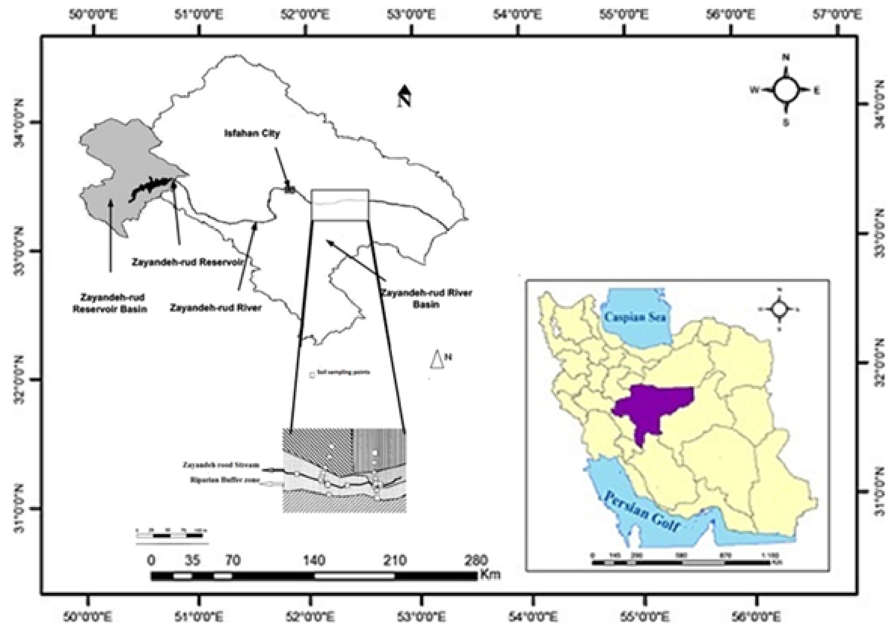

Figure 1 Distribution map of the study area.

Biodiversity data analysis

The diversity indices of richness, evenness, and biodiversity were evaluated for plant diversity through using the most common methods of their estimation mentioned in previous studies.[19,20]

Richness-Different methods were suggested by many investigators to measure this index and the number of species (n) as the species richness (s) is the most common method among others.[21,22]

Evenness-Simpson's evenness index is defined as:

$$E_{1/D} = \frac{1/D}{n} \quad [1]$$

Where D is Simpson's biodiversity index and n is the number of species. As is the case for Simpson, this method is less sensitive to rare species. Camargo's evenness index is calculated by:

$$\dot{E} = 1 - \sum_{n_1=1}^{n} \sum_{n_2=n_1+1}^{n} \left| p_{n_1} - p_{n_2} \right| \Big/ n \quad [2]$$

Where P_n is species frequency and n is the number of species. Smith & Wilson (1996) suggested a new method that is based on species frequency. This method is sensitive to rare and dominant species of the community. It is measured through the equation:

$$E_{var} = 1 - 2/\pi \arctan\left[\sum_{n_1=1}^{n} \left(\ln\left(x_{n_1}\right) - \sum_{n_2=1}^{n} \left(\ln\left(x_{n_2}\right)\right) \Big/ n \right)^2 \Big/ n \right] \quad [3]$$

Where n_1 is the number of individuals of the first species, n_2 is the number of individuals of the second species, and n is the number of all individuals in all species.

Biodiversity-Simpson is the most common and frequently used biodiversity index.[23,24] This method is measured by:

$$D = 1 - \sum_{i=1}^{n} p_i^2 \quad [4]$$

Where n is the number of species and p_i is the relative frequency of each species. The other popular method of biodiversity measurement is Shannon-Wiener. It estimates the average uncertainty in assigning each randomly chosen individual to the species it belongs to. The following equation is applied:

$$H' = \sum_{i=1}^{n} p_i \ln p_i \quad [5]$$

Where n is the number of species and p_i is the relative frequency of each species. The third method of biodiversity estimation is Brillouin. It is similar to Shannon-Wiener and is applied when random selection of samples is doubtful and is defined as:

$$HB = 1/n \ln n! / n_1! n_2! \quad [6]$$

Where n_1 is the number of individuals of the first species, n_2 is the number of individuals of second species and n is the number of all individuals in all species.

Results and discussion

Monitoring is the key to understand the environmental sustainability and the RBZ efficiency. Therefore, perimeter, area, width, latitude and longitude of six RBZs were measured in agricultural land along Zayanderud. Results showed that the first zone has a larger area and the second zone has a higher perimeter and path length than the other (Tables 1&2). Therefore, in order to conduct a fine comparison of the zones, six20×20 m^2 plots (400m^2) were selected in six mentioned RBZs.

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Table 1 Measurement of perimeter, area, length, latitude and longitude of the six buffer zone in agricultural land along Zayanderud

	Perimeter (km)	Area (Ha)	Path length (km)	Latitude	Longitude
First zone	1.47	4.31	0.28	32.6298	51.5614
Second zone	3.17	3.84	1.38	32.5963	51.5645
Third zone	0/6	0/54	0/27	32/6348	51/5622
Forth zone	0/46	0/24	0/22	32/6333	51/5628
Fifth zone	0/22	0/09	0/1	32/631	51/5617
Sixth zone	2/19	2/04	0/94	32/6272	51/5656

Table 2 The composition of tree species in the six zones

	Dominant species	Family	Average diameter at breast (cm)	Average height (m)	Diameter standard deviation (cm)	Height standard deviation (m)
	Fraxinusrotundifolia Mill	Oleaceae	20.15	11.25	2.68	0.79
	Salix alba L.	Salicaceae	29.45	10.55	2.4	0.91
	Elaeagnusangustifolia L.	Elaeagnaceae	18.8	9.37	1.5	1.51
First Zone	*Populusnigra L*	Salicaceae	19.1	17	1.01	1.01
	Morus alba L.	Moraceae	19.85	12.5	1.1	1.45
Second zone	*Populusnigra L*	Salicaceae	21.11	17.35	1.11	0.99
Third zone	*Salix alba L.*	Salicaceae	27.85	9.13	1.9	1.11
	Populusnigra L	Salicaceae	19.89	18	1.81	1.05
Forth zone	*Salix alba L.*	Salicaceae	28.92	11.02	1.98	0.86
	Elaeagnusangustifolia L.	Elaeagnaceae	17.8	9.44	1.37	1.43
	Populusnigra L	Salicaceae	20.78	18.05	0.89	1.09
Fifth zone	*Elaeagnusangustifolia L.*	Elaeagnaceae	17.72	9.04	1.07	1.03
	Morus alba L.	Moraceae	18.15	11.54	1.81	1.05
	Fraxinusrotundifolia Mill	Oleaceae	21.05	10.25	2.55	0.76
Sixth zone	*Salix alba L.*	Salicaceae	27.95	11.05	2.1	1.9
	Populusnigra L	Salicaceae	18.32	16.67	1.79	1.35

Species compositions

Species compositions were assessed in six zones. Results are shown in Table 2.

Biodiversity indices' data

Indices were calculated for each zone and the results are shown in Table 3.

Table 3 Biodiversity Indices in the first zone

First zone		Second zone	Third zone	Forth zone	Fifth zone	Sixth zone
Biodiversity indexes	value	value	value	value	value	value
Richness	5	1	2	3	3	2
Evenness (Camargo)	0.823	1	0.895	0.887	0.859	0.843
Evenness (Simpson)	0.893	1	0.901	0.899	0.889	0.879
Evenness (Smith and Wilson)	0.938	1	0.981	0.923	0.967	0.956
Heteroginity (Simpson (1-D))	0.787	0	0.529	0.601	0.636	0.501
Heteroginity (Brillouin)	2.076	0	1.882	1.991	2.001	1.793
Heteroginity (Shanon H)	2.242	0	2.091	2.167	2.178	2.031

Results showed that richness in the first zone (n=5) was higher than that of the other zone (n=1) and evenness in the second zone (1) was higher than that of the first zone (average 0.884) and other zone. Moreover, heteroginity indices were relatively higher in the first zone.

P and N concentrations

P and N concentrations were determined in 3 parallel transects and are shown in Figures 2&3. The results showed that there is significant relationship between the zone-point in all RBZ. This correlation is highest between the first and second zone. The results of measuring the concentration of N and P in soil in the all zones revealed that the highest N and P concentration is related to the end of the farm and the lowest concentration is related to the end of the buffer zone. N and P concentrations in soil in the first zone increased significantly from the beginning of the farm to the end of the farm, and then decreased sharply from the beginning of the buffer zone to the end of it, as average concentration of N and P dropped from 0.33 mg L^{-1} to 0.035 mg L^{-1}, and from 6.97 mg L^{-1} to 1.74 mg L^{-1}, respectively (P value< 0.05).

Figure 2 Average concentration of N forms (mg/l) in three parallel transects of six zones in RBZ.

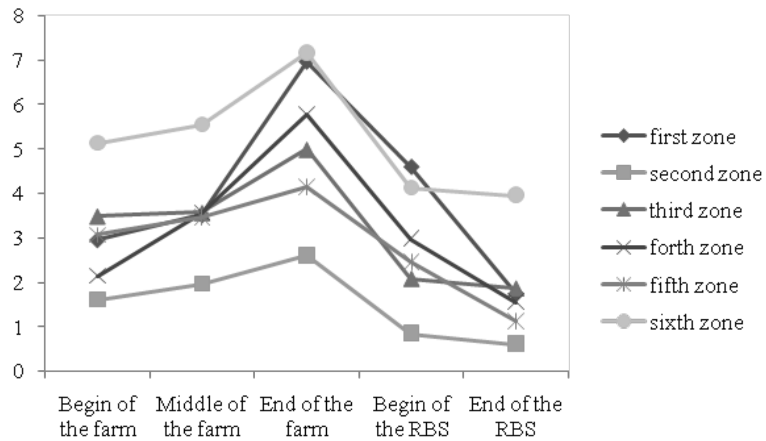

Figure 3 Average concentration of P forms (mg/l) in three parallel transects of six zones in the RBZ.

The average concentration of N and P in soil in the second zone dropped from 1.01 mgL^{-1} to 0.07 mgL^{-1} and from2.6 mgL^{-1} to 0.6mgL^{-1}, respectively (P value< 0.05). The results of the comparison between the six zones indicated that the concentration of N in the first (total=0.968 mgL^{-1}) zone is less than that of the other zone (total=1.78 mgL^{-1}) and the concentration of Pin the first zone (total=19.77 mgL^{-1}) is more than that of the other zone (total=7.61 mgL^{-1}). (Tables 4&7).

A two-way between-groups analysis of variance was conducted to explore the impact of biodiversity and the location of points on levels of Nitrogen reduction in the RBZ, measured through sampling N concentrations in 5 points in 2 zones. Each zone was sampled in 5 different points (Point 1: Beginning of the Farm, Point 2: Middle of the Farm, Point 3: End of the Farm, Point 4: Beginning of the RBZ, Point 5: End of the RBZ). The interaction effect between the zones and the points was statistically significant, with F=14.092 and p =0.000 (Table 5), which means the different biodiversity indices in the six zones had an effect on the N reduction. There was a statistically significant main effect for points(F = 36.707, p = .000); moreover, the effect size was large (partial eta squared =.880). Post-hoc comparisons using the Turkey HSD test (Table 6) indicated that the mean score for point 1(M = .33500, SD = .073959) was significantly differentfrompoints3 (M = .66833, SD = .417105), and 4(M=.10667, SD=.053200).Point 2 (M = .21333, SD = .077115) did not differ significantly from either of the other points, except for point 3 (M = .66833, SD = .417105). Point 4 (M=.10667, SD=.053200) was significantly different from point 1 (M = .33500, SD = .073959) and point 3 (M = .66833, SD = .417105), but did not differ significantly from point 5 (M = .05250, SD = .027318). Point 5 (M = .05250, SD = .027318), like point 4 (M=.10667, SD=.053200), was significantly different from points 1 (M = .33500, SD = .073959) and 3 (M = .66833, SD = .417105).The main effect for Zone(F= 19.991, p = .000)reached statistical significance with partial eta squared of 0.5, showing a large effect.

Table 4 Descriptive statistics of N reduction through RBZ in first zone and second zone

Point	Zone	Mean	Std. Deviation	N
	Zone 1 (Biodiversified)	.28000	.026458	3
Beginning of the farm	Zone 2	.39000	.062450	3
	Total	.33500	.073959	6
	Zone 1 (Biodiversified)	.26667	.037859	3
Middle of the farm	Zone 2	.16000	.070000	3
	Total	.21333	.077115	6
	Zone 1 (Biodiversified)	.32667	.058595	3
End of the farm	Zone 2	1.01000	.285132	3
	Total	.66833	.417105	6
	Zone 1 (Biodiversified)	.06333	.023288	3
Beginning of the RBZ	Zone 2	.15000	.030000	3
	Total	.10667	.053200	6
	Zone 1 (Biodiversified)	.03500	.015716	3
End of the RBZ	Zone 2	.07000	.026458	3
	Total	.05250	.027318	6
	Zone 1 (Biodiversified)	.19433	.128343	15
Total	Zone 2	.35600	.373971	15
	Total	.27517	.286753	30

Table 5 Tests of Between-Subjects Effects of N

Source	Type III sum of squares	df	mean square	F	Sig.	partial eta squared
Corrected Model	2.188[a]	9	.243	24.798	.000	.918
Intercept	2.272	1	2.272	231.653	.000	.921
Point	1.440	4	.360	36.707	.000	.880
Zone	.196	1	.196	19.991	.000	.500
Point * Zone	.553	4	.138	14.092	.000	.738
Error	.196	20	.010			
Total	4.656	30				
Corrected Total	2.385	29				

a. R Squared = .918 (Adjusted R Squared = .881)

Table 6 Multiple comparison of N by Tukey HSD

(I) Point	(J) Point	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Beginning of the Farm	Middle of the Farm	0.12167	0.057171	0.247	-0.04941	0.29274
	End of the Farm	-.33333*	0.057171	0	-0.50441	-0.16226
	Beginning of the RBZ	.22833*	0.057171	0.006	0.05726	0.39941
	End of the RBZ	.28250*	0.057171	0.001	0.11142	0.45358
Middle of the Farm	Beginning of the Farm	-0.12167	0.057171	0.247	-0.29274	0.04941
	End of the Farm	-.45500*	0.057171	0	-0.62608	-0.28392
	Beginning of the RBZ	0.10667	0.057171	0.366	-0.06441	0.27774
	End of the RBZ	0.16083	0.057171	0.072	-0.01024	0.33191

Table Continued...

(I) Point	(J) Point	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
End of the Farm	Beginning of the Farm	.33333*	0.057171	0	0.16226	0.50441
	Middle of the Farm	.45500*	0.057171	0	0.28392	0.62608
	Beginning of the RBZ	.56167*	0.057171	0	0.39059	0.73274
	End of the RBZ	.61583*	0.057171	0	0.44476	0.78691
Beginning of the RBZ	Beginning of the Farm	-.22833*	0.057171	0.006	-0.39941	-0.05726
	Middle of the Farm	-0.10667	0.057171	0.366	-0.27774	0.06441
	End of the Farm	-.56167*	0.057171	0	-0.73274	-0.39059
	End of the RBZ	0.05417	0.057171	0.875	-0.11691	0.22524
End of the RBZ	Beginning of the Farm	-.28250*	0.057171	0.001	-0.45358	-0.11142
	Middle of the Farm	-0.16083	0.057171	0.072	-0.33191	0.01024
	End of the Farm	-.61583*	0.057171	0	-0.78691	-0.44476
	Beginning of the RBZ	-0.05417	0.057171	0.875	-0.22524	0.11691

Based on observed means.

The error term is Mean Square(Error) = .010.

*The mean difference is significant at the .05 level.

Table 7 Descriptive statistics of P reduction through RBZ in first zone and second zone

Point	Zone	Mean	Std. Deviation	N
Beginning of the Farm	Zone 1 (Biodiversified)	2.95	0.967006	3
	Zone 2	1.6	0.457056	3
	Total	2.275	1.002173	6
Middle of the Farm	Zone 1 (Biodiversified)	3.51	0.530189	3
	Zone 2	1.95667	0.567656	3
	Total	2.73333	0.982439	6
End of the Farm	Zone 1 (Biodiversified)	6.97	2.150047	3
	Zone 2	2.6	0.39281	3
	Total	4.785	2.764031	6
Beginning of the RBZ	Zone 1 (Biodiversified)	4.6	1.3	3
	Zone 2	0.85	0.471275	3
	Total	2.725	2.232396	6
End of the RBZ	Zone 1 (Biodiversified)	1.74	1.099864	3
	Zone 2	0.6	0.081854	3
	Total	1.17	0.936184	6
Total	Zone 1 (Biodiversified)	3.954	2.143741	15
	Zone 2	1.52133	0.836864	15
	Total	2.73767	2.021672	30

Table 8 Tests of Between-Subjects Effects of P

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	99.222a	9	11.025	11.421	0	0.837
Intercept	224.845	1	224.845	232.931	0	0.921
Point	41.18	4	10.295	10.665	0	0.681
Zone	44.384	1	44.384	45.98	0	0.697
Point * Zone	13.658	4	3.414	3.537	0.024	0.414
Error	19.306	20	0.965			
Total	343.372	30				
Corrected Total	118.528	29				

a. R Squared = .837 (Adjusted R Squared = .764)

Table 9 Multiple comparison of P by Tukey HSD

(I) Point	(J) Point	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Beginning of the Farm	Middle of the Farm	-0.45833	0.56724	0.925	-2.15573	1.23906
	End of the Farm	-2.51000*	0.56724	0.002	-4.20739	-0.81261
	Beginning of the RBZ	-0.45	0.56724	0.93	-2.14739	1.24739
	End of the RBZ	1.105	0.56724	0.326	-0.59239	2.80239
Middle of the Farm	Beginning of the Farm	0.45833	0.56724	0.925	-1.23906	2.15573
	End of the Farm	-2.05167*	0.56724	0.013	-3.74906	-0.35427
	Beginning of the RBZ	0.00833	0.56724	1	-1.68906	1.70573
	End of the RBZ	1.56333	0.56724	0.08	-0.13406	3.26073
End of the Farm	Beginning of the Farm	2.51000*	0.56724	0.002	0.81261	4.20739
	Middle of the Farm	2.05167*	0.56724	0.013	0.35427	3.74906
	Beginning of the RBZ	2.06000*	0.56724	0.013	0.36261	3.75739
	End of the RBZ	3.61500*	0.56724	0	1.91761	5.31239
Beginning of the RBZ	Beginning of the Farm	0.45	0.56724	0.93	-1.24739	2.14739
	Middle of the Farm	-0.00833	0.56724	1	-1.70573	1.68906
	End of the Farm	-2.06000*	0.56724	0.013	-3.75739	-0.36261
	End of the RBZ	1.555	0.56724	0.083	-0.14239	3.25239
End of the RBZ	Beginning of the Farm	-1.105	0.56724	0.326	-2.80239	0.59239
	Middle of the Farm	-1.56333	0.56724	0.08	-3.26073	0.13406
	End of the Farm	-3.61500*	0.56724	0	-5.31239	-1.91761
	Beginning of the RBZ	-1.555	0.56724	0.083	-3.25239	0.14239

Based on observed means.

The error term is Mean Square (Error) = .965.

*The mean difference is significant at the .05 level.

Conclusion

RBZ differences can create sustainable environment if they evaluate and manage properly. Generally, results showed that N and P were accumulated from the beginning to the end of the farm, as there was a 0.13%and a 0.87% increase per meter for N and a 0.50% and a 26 % increase per meter for P at the first and second zones, respectively. Subsequently, at the start of the root system in the mentioned tree area in the beginning of the RBZ, a 1.38% and a 2.41 % reduction per meter for N concentration and a 0.59% and a 1.15% reduction per meter for P concentration were observed in the first and the second zones, respectively. Eventually, due to the final completion of phytoremediation and integral effect of the root system of trees in the RBZ, a 0.3% and a 0.45 % reduction in N concentration and a 1.45% and a 0.33% reduction in P concentration were seen at the end of the RBZ in the first and second zones, respectively.

Results of this study showed that the difference between biodiversity indexes, which is primarily due to the diversity of species composition, influences the effectiveness of the RBZ. According to Wu et al., 2017 there are significant changes in habitat class level between indices. However, a regular trend cannot be observed among the RBZs. Generally, according to the indexes shown in Table3, in the first zone, which has lower evenness and higher biodiversity, the effectiveness of RBZ in N removal is 31%, around 22% lower than the second zone with high evenness and low biodiversity. Therefore, it could be assumed that evenness probably has a direct relation with RBZ reduction of Nitrogen. Effectiveness of the RBZ in P removal is almost equal in both zones, and the detailed view of this trend shows that P has a disordered behavior in soil and hence, exact conclusions cannot be drawn. There was a significant difference in the diversity indices values in study done by Singh and Singh (2013) and they claim plant diversity indices as useful parameters for comparison of six communities.

In a study done by Hefting et al.,[25] RBZs were introduced as effective approaches for the reduction of N which corresponds to the results of the current study at an approximately equivalent rate. Moreover, Borin et al.,[11] presented RBZ as a means to reduce P with a high satisfactory rate. According to the results of soil, it could be suggested that soil has an important role in N and P reduction. Boz et al.,[8] claimed that the composition of soil microbial community and activity could be altered by appropriate manipulation of the environment in which they live. Moreover, Wu et al.,[26] argued that changes of soil bacterial community richness and diversity affect nitrogen cycling of the ecosystem and also had the greatest efficiency on soil amendment .If correctly used, the mentioned approach has the capability to attenuate the extra chemicals effectively.

It could be suggested that the significant reduction of N and P pollutants in the RBZ is, relying on their effective phytoremediation properties, due to the combination of ash (*Fraxinusrotundifolia*), willow (*Salix alba*), buckthorn (*Elaeagnusangustifolia*), poplar (*Populusnigra*) and mulberry (*Morus alba*). *Fraxinusrotundifolia* was one of the most frequent species in this region and numerous ecological and geographical ranges are allocated to it. Moreover, it is available and inexpensive and has effective properties in remediation of N and P and also zinc and copper.[27] *Salix alba*is an important economic species and has efficient properties in absorption of N, P, zinc, lead, copper and iron.[28] In addition to its phytoremediation properties for oil and gas pollution, *Elaeagnusangustifolia*is an effective species to halt erosion.[29] According to a study done by Minoguea et al.,[30] in 2012, *Populusnigra*, as a fast growing woody plant, has important phytoremediation properties for N and P reduction. Qin et al.,[31] introduced *Morusalba* with very strong root systems, high environmental compatibility, affordability, and accessibility, with properties for reduction of copper, zinc, nickel, lead and P. Therefore, it can be suggested that species type and composition plays an important role in the reduction of pollution.[32,33]

In order to conduct further research in this area, and to correctly estimate the effect of phytoremediation of different species in an RBZ, it is proposed that phytoremediation of the species found in the RBZ be evaluated in greenhouse conditions for both isolated (individual) and combined sets of the mentioned species.

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Conflicts of interest

The author declares there are no conflicts of interest.

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