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Research Article

Seasonal and Spatial Variation of Dissolved Oxygen and Nutrients in Padaviya Reservoir, Sri Lanka

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Lakes, reservoirs, rivers, and aquifers are important freshwater sources for basic human needs such as drinking, sanitation, and agriculture. The anthropogenic influences on the natural environment, especially on freshwater resources, have increased dramatically during the last few decades. Eutrophication and pollution are major threats to many of these water bodies. There are thousands of man-made reservoirs, which are centuries old in Sri Lanka, and only a handful of them have been extensively studied and monitored. This study investigates the spatial and seasonal variations of water quality in Padaviya Reservoir by studying the vertical distribution of physical parameters and inorganic nitrogen species: ammonia, nitrite and nitrate, reactive phosphate, and dissolved oxygen. Padaviya Reservoir, which is an ancient man-made irrigation reservoir, has never been studied in detail to assess its water quality. Sharp chemical gradients for ammonia, nitrite, nitrate, reactive phosphate, and dissolved oxygen were observed between surface and bottom waters of the reservoir, suggesting that it does not overturn completely. The temperature difference is between the surface and bottom waters of about 2°C, which is not large enough to cause thermal stratification. The most probable reason for the stratification is extensive photosynthesis at surface waters with subsequent decomposition of the organic material at the bottom.

1. Introduction

The artificial water bodies such as reservoirs are of extreme importance as ecological and economical sources of freshwater for basic human needs of drinking, sanitation, and agriculture [1]. Reservoirs are also considered as important components of infrastructure and as a part, which improves the life quality and standards for people living in the region. Nevertheless, the extent of anthropogenic influences on the natural environment, especially the influence on freshwater resources, has increased dramatically during the last few decades. Nutrient overenrichment or eutrophication is a major threat to many freshwater and coastal marine ecosystems [2–10]. One of the most commonly visible effects of eutrophication is the accumulation of cyanobacterial harmful algal blooms [11–13]. Harmful cyanobacterial blooms have many detrimental effects on the natural environment as a whole [9, 13, 14]. Some cyanobacterial blooms are capable of producing toxins, also known as cyanotoxins that are potent neuro- and hepatotoxins [2, 13]. In addition, cyanobacterial blooms are also associated with reduced dissolved oxygen levels which can be lethal to fish and other aquatic organisms [14].

Sediments in reservoirs also play an important role by acting as both a nutrient source and sink. In lakes and reservoirs, phosphorus (P) release from the sediments (i.e., internal loading) may substantially increase the bioavailable phosphate pool and consequently the algal biomass [15]. Phosphorus release is a complex function of physical and chemical parameters such as temperature, nitrate concentration, pH, and input of organic matter [16–18] and biological processes [19]. The exchange of P across the sediment-water interface usually increases when the surface of the sediments becomes anoxic [15, 20]. Significant amounts of nitrogen and phosphorus are released as ammonium and phosphate into the bottom water layers which are in contact with sediments during the mineralization of organic matter. This buildup of nutrients in reservoirs degrades the quality of water by initiating eutrophication [21, 22]. In addition to nutrients, pollution of reservoirs and lakes by heavy metals [1, 7, 23–26] and organic pollutants [27–30] also has been reported in literature.

Sri Lanka is a tropical island in the Indian Ocean, southeast of the Bay of Bengal, with mean temperatures of 17°C in the central highlands to 27°C in lowlands. The rainfall distribution throughout the island is dominated by two monsoons: southwest and northeast, prevailing from April to September and October to March, respectively [31, 32]. The dry climate zone, which receives less than 1500 mm of rainfall per year, is benefitted by a sophisticated system of reservoirs connected with canals resembling a cascade system, which was built in the ancient times to supply freshwater for basic human needs and most importantly for agriculture [33–35]. At present, there are approximately 3500 reservoirs in Sri Lanka, and a majority of them were built from the 3rd century to 12th century BC [36]. Although there are thousands of reservoirs in Sri Lanka, only a handful of them have been extensively studied and monitored [37–43]. This is contrary to many other countries where water quality monitoring programs of reservoirs and lakes are common [2, 3, 5, 8, 44–48]. Padaviya Reservoir (8°49′30.6″ N 80°46′2.05″ E, 75 m above sea level) is a shallow man-made irrigation reservoir situated at the District of Anuradhapura, Sri Lanka's North Central Province (Figure 1). It is widely believed to have been constructed during King Mahasena's reign from 274 to 301 A.D. It has been extensively renovated and expanded since then, and the most recent restoration was completed in 1954 giving its current shape and a maximum water holding capacity of approximately 0.1 km^3. It is built by the impounding seasonal streams of Mora Oya and Mukunu Oya, to create a water spread area of 56.6 km^2 with a catchment area of approximately 270 km^2 [49, 50]. The surface water level of the reservoir dramatically decreases in the dry season, and the littoral zone cover terrestrial plants and grass that turn into feeding grounds to free range cattle and herds of elephants. The average depth of the reservoir is around 8.8 m, and the depth increases towards the embankment. Padaviya Reservoir acts as a major and an important part in Sri Lanka's dry zone and provides a source of income for thousands of people mainly from agriculture (paddy) and commercial freshwater fishing industry. In addition, it provides a habitat for wildlife in the Padaviya wildlife sanctuary. It also is an important water source for the local residents and a water source for livestock, especially in the driest seasons.

This study investigates the water quality in Padaviya Reservoir by studying the vertical distribution of nitrogen species (nitrate, nitrite, and ammonia), reactive phosphate, dissolved oxygen, conductivity, and pH. It has never been studied in detail to assess its water quality, and for the first time, we have carried out a year-long study to investigate the vertical distribution of the abovementioned physical and nutrient parameters in the reservoir.

2. Materials and Methods

2.1. Sample Collection. Water samples were collected in 2-month intervals. At the initial states of the study, samples were collected at arbitrary locations covering the entire reservoir, thereafter; three locations are selected, as shown in Figure 2, based on the shape of the reservoir and on the data collected from the initial field visits.

2.2. Water Quality Analysis. The water quality parameters were analyzed onsite and in the laboratory. Onsite measurements were carried for temperature, pH, conductivity, and dissolved oxygen. The dissolved oxygen concentration (DO) and pH were measured *in situ* at 0.5 m depth intervals from the top to bottom of the water column using YSI Pro 10 and Pro 20 (Yellow Springs Instruments, Yellow Springs, OH, USA) handheld meters equipped with 20 m field cables. Water samples required for chemical analysis were collected by a Van Dorn sampler at 0.5 m depth intervals. A small portion of the unfiltered sample was used to determine the conductivity using a Eutech Cond 6+ (Thermo Fisher Scientific, Waltham, MA, USA) portable conductivity meter, and the remaining sample was filtered through pre-acid-washed nylon membrane filters (0.45 μm) and stored in clean, acid-washed polyethylene sampling bottles. The samples were analyzed in the field for nitrite, nitrate, and ammonia using the YSI 9500 (Yellow Springs Instruments, Yellow Springs, OH, USA) photometer. Reactive phosphate was analyzed by the molybdate assay method [51].

3. Results and Discussion

3.1. Variation of the Water Depth. Average reservoir depth varied significantly during the study period, and the depth was at the spillover limit of 8 m at the beginning of the year (2016) and remained at that depth until March. Thereafter, the water level decreased from about 6 m on May to 3.5 m on October. Water level increased marginally to 4 m on November and finally decreases to 3 m on December.

3.2. Water Temperature and Conductivity. The variation of the water temperature and conductivity of the reservoir during the study period is shown in Figure 3. The surface water temperatures of the reservoir varied between 28.2 ± 0.4°C and 29.5 ± 0.4°C, and the bottom water temperatures varied between 26.5 ± 0.6°C and 29.0 ± 0.6°C. The maximum water temperature difference between the surface and bottom layers was about 2°C which is not large enough to cause thermal stratification. Temperature plays an important role in the physical and chemical characteristics in most reservoirs, such as the pronounced effect on the rate of CO_2 fixation by primary productivity. In addition, temperature affects the bacterial activities, which is responsible for the decomposition of organic matter for nutrient recycling and solubility of gases like O_2, CO_2, and NH_3. The average conductivity of surface and bottom waters was $223 \pm 61\,\mu\text{S}\cdot\text{cm}^{-1}$ and $687 \pm 314\,\mu\text{S}\cdot\text{cm}^{-1}$, respectively. The conductivity of bottom waters was significantly greater than

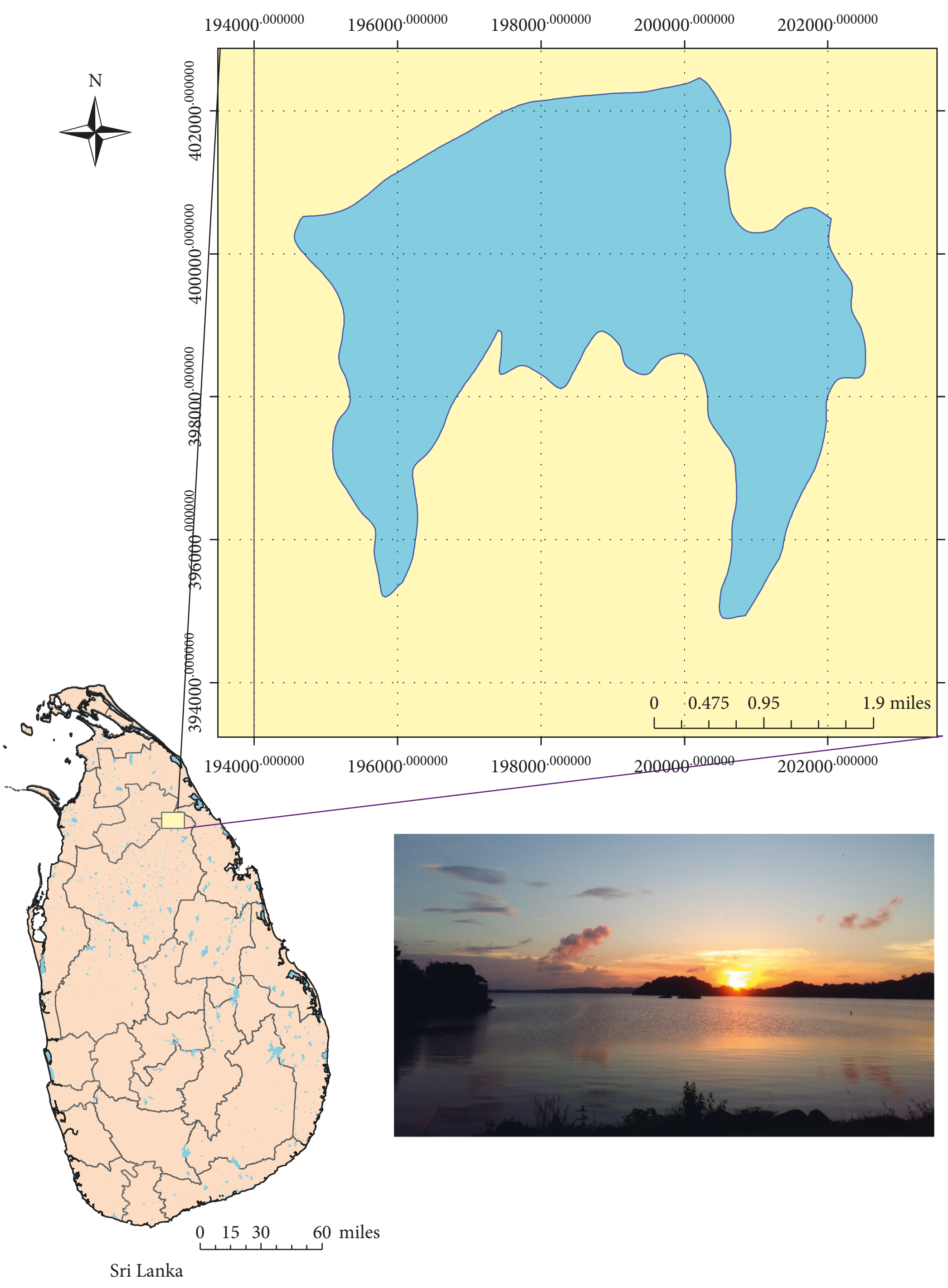


Figure 1: Padaviya Reservoir.

the surface waters. The highest conductivity was recorded in December at bottom waters, and the lowest was recorded at surface water layers in March; the values were 1183 ± 82 μS·cm^{-1} and 156 ± 15 μS·cm^{-1}, respectively. The decrease in electric conductivity observed in November might have been occurred due to the formation of insoluble salts, especially phosphates and carbonates. In addition, a heavy rainfall of about 350 mm received in November has delivered a significant amount of rainwater to the reservoir which in turn increased the water level by about 0.5 m from 3.5 m in October to 4.0 m in November. Rainwater generally contains only a few dissolved salts and has a very low electric conductivity. Padaviya Reservoir has a surface area of about 56 km^2 to collect rainfall directly onto the reservoir. As a result, the addition of significant amounts of rainwater has significantly diluted the reservoir decreasing its overall conductivity. The rainfall did not create significant surface flows that are usually higher in conductivity or any significant water

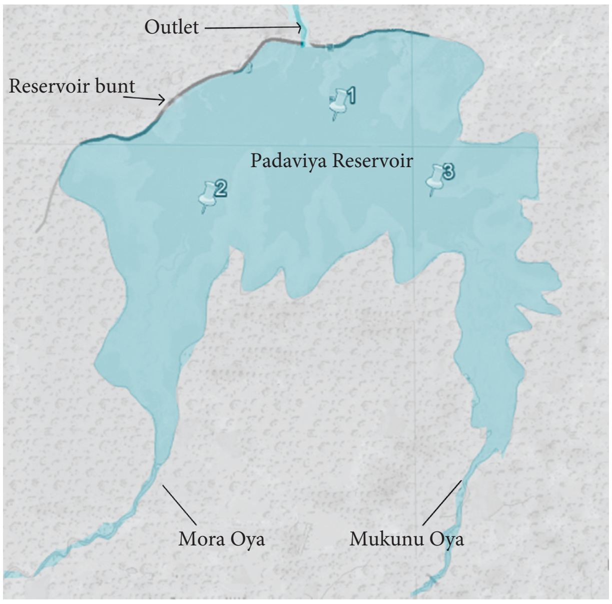


Figure 2: Sampling locations at the Padaviya Reservoir. Main sampling stations monitored in the study are shown as 1, 2, and 3.

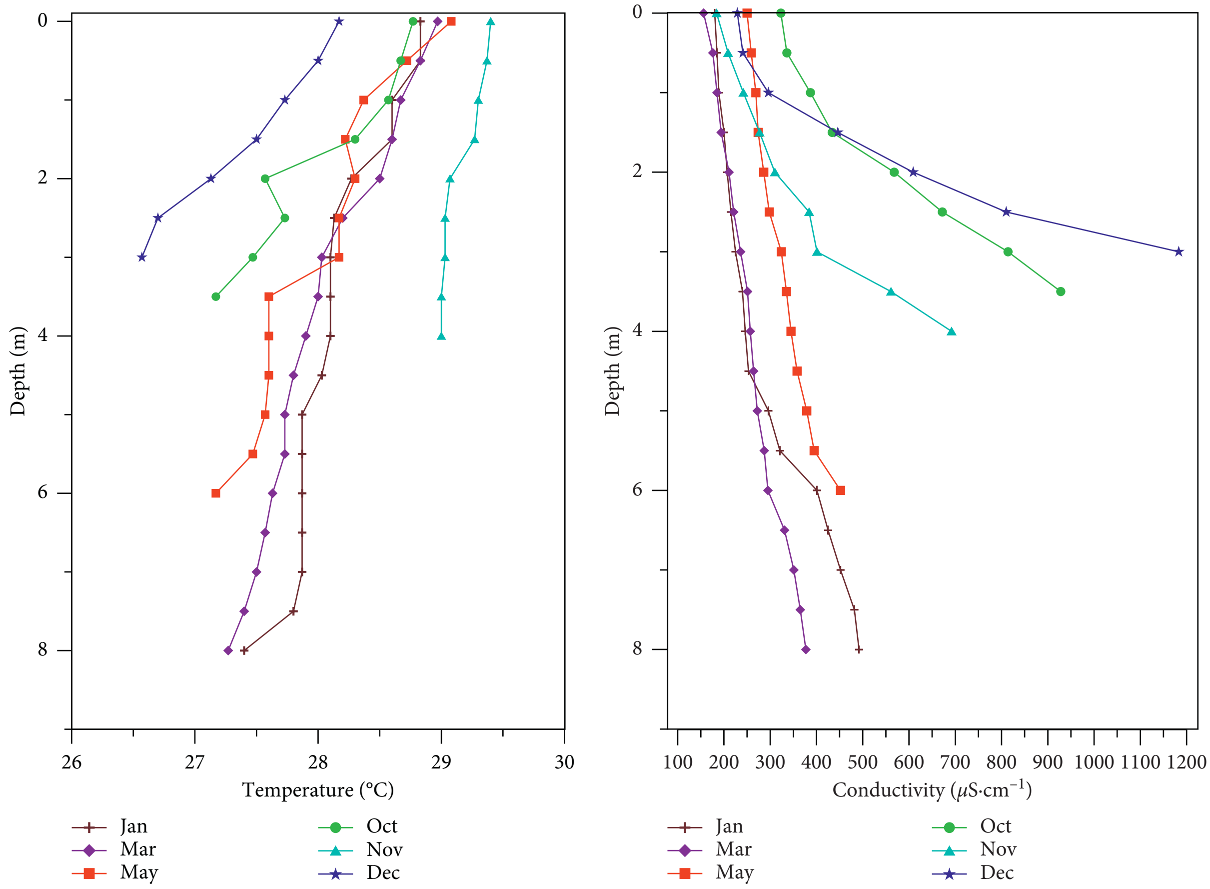
flows from its two seasonal streams, Makunu Oya and Mora Oya, mainly because most of the precipitation was adsorbed by dry soils and sediments which have not received any precipitation from July to September. The electric conductivity increased significantly in December most probably due to the decomposition on submerged terrestrial vegetation in the littoral zone after the rainfall. This assumption is confirmed by the increase of concentrations of ammonia, nitrate, nitrate, and reactive phosphate in December.

3.3. pH and Dissolved Oxygen (DO). The variation pH and DO in the reservoir during the study period is shown in Figure 4. The average pH of the surface and bottom waters of the reservoir was 7.95 ± 0.35 and 7.03 ± 0.59, respectively. The highest pH was recorded in October at surface waters, and lowest was recorded at bottom waters in December; the values were 8.65 ± 0.08 and 6.27 ± 0.20, respectively. There is a noticeable pH decrease from October to November compared to gradual pH changes observed in other months. This significant pH decrease could have been resulted from the decomposition of submerged terrestrial vegetation in the littoral zone of the reservoir after a heavy rainfall in November. The average DO of reservoir surface and bottom waters was 7.39 ± 0.65 $\mathrm{mgL^{-1}}$ and 0.10 ± 0.05 $\mathrm{mgL^{-1}}$, respectively. The highest DO concentrations was recorded in March at the surface waters, and lowest was recorded at the bottom layer in December; DO values were 8.30 ± 0.16 $\mathrm{mgL^{-1}}$ and 0.04 ± 0.01 $\mathrm{mgL^{-1}}$, respectively. The surface waters were well oxygenated; however, the bottom waters were depleted of oxygen and anoxic. The thickness of the anoxic bottom layer was approximately 2 m between January and May; however, it significantly reduced to about 0.5 m during the rest of the year. The depletion of dissolved oxygen at the bottom waters could be attributed to the microbial decomposition of dissolved and particulate organic matter of phytoplankton origin. In addition to that, littoral zones that are covered with terrestrial shrubs and grass inundate in the rainy seasons provide an ample supply of organic matter to the reservoir. The microbial biodegradation of phytoplankton biomass and humic substances can significantly decrease DO concentrations that lead to hypolimnetic anoxia [52]. The slow rates of mixing and calm waters at the sediment-water interface can result in the formation of a thick diffusive boundary layer, which impedes oxygen diffusion at bottom water layers and sediments [52, 53]. Unlike the lakes and reservoirs in the temperate and northern latitudes, Padaviya Reservoir does not undergo thermal stratification, and therefore, spring and summer turnover events that circulate the entire water columns do not occur. To our knowledge, the existence of a year-long anoxic bottom stratum has never been reported in any Sri Lanka reservoir to date.

3.4. Reactive Phosphate and Inorganic N Species: Nitrite, Nitrate, and Ammonia. The variation of the concentrations of inorganic N species and reactive phosphate is shown in Figure 5. The average nitrite, nitrate, and ammonia concentrations of the surface waters were 0.40 ± 0.61 $\mathrm{mgL^{-1}}$, 0.75 ± 0.40 $\mathrm{mgL^{-1}}$, and 0.10 ± 0.06 $\mathrm{mgL^{-1}}$, respectively, and the concentrations of the bottom waters were 2.50 ± 0.35 $\mathrm{mgL^{-1}}$, 0.05 ± 0.02 $\mathrm{mgL^{-1}}$, and 0.95 ± 0.65 $\mathrm{mgL^{-1}}$, respectively. Surface waters were depleted of $\mathrm{NH_4}^+$ and $\mathrm{NO_2}^-$, and the concentrations increased rapidly with the depth of the water column. The main contributor to inorganic N species in the bottom water layer is sediments and anoxic conditions prevailing at bottom waters that enable release of inorganic N to the bottom waters causing accumulation [54].

The average reactive phosphate concentration at surface and bottom waters was 0.18 ± 0.06 $\mathrm{mgL^{-1}}$ and 1.99 ± 0.66 $\mathrm{mgL^{-1}}$, respectively. The highest reactive phosphate concentration was recorded in December at the bottom waters, and the lowest concentration was recorded in October at the surface waters; the values were 3.10 ± 0.02 $\mathrm{mgL^{-1}}$ and 0.10 ± 0.08 $\mathrm{mgL^{-1}}$, respectively. The reactive phosphate concentration decreases gently from the surface to a depth of approximately 5 m, and then, there is sharp concentration increase from a depth of 5 m to 8 m between January and May when the reservoir water level was at its maximum. The reactive phosphate concentration gradient between the surface and bottom waters is more profound during October to December than January to May. The reactive phosphate concentration increased by a factor of 10 from the surface to bottom waters in about 3 m between October and December.

Wimalawansa [40] reported that mean phosphate concentration in the Padaviya Reservoir is 0.09 $\mathrm{mgL^{-1}}$. According to their study, the highest P concentration of 0.14 $\mathrm{mgL^{-1}}$ was observed in April and June and the lowest P concentration, 0.03 $\mathrm{mgL^{-1}}$, was observed in August. They concluded that the reservoir is eutrophic during certain periods of the year based on the monthly phosphorous concentrations. Although it is not clearly mentioned in the article, the P concentrations reported by Wimalawansa



(a)

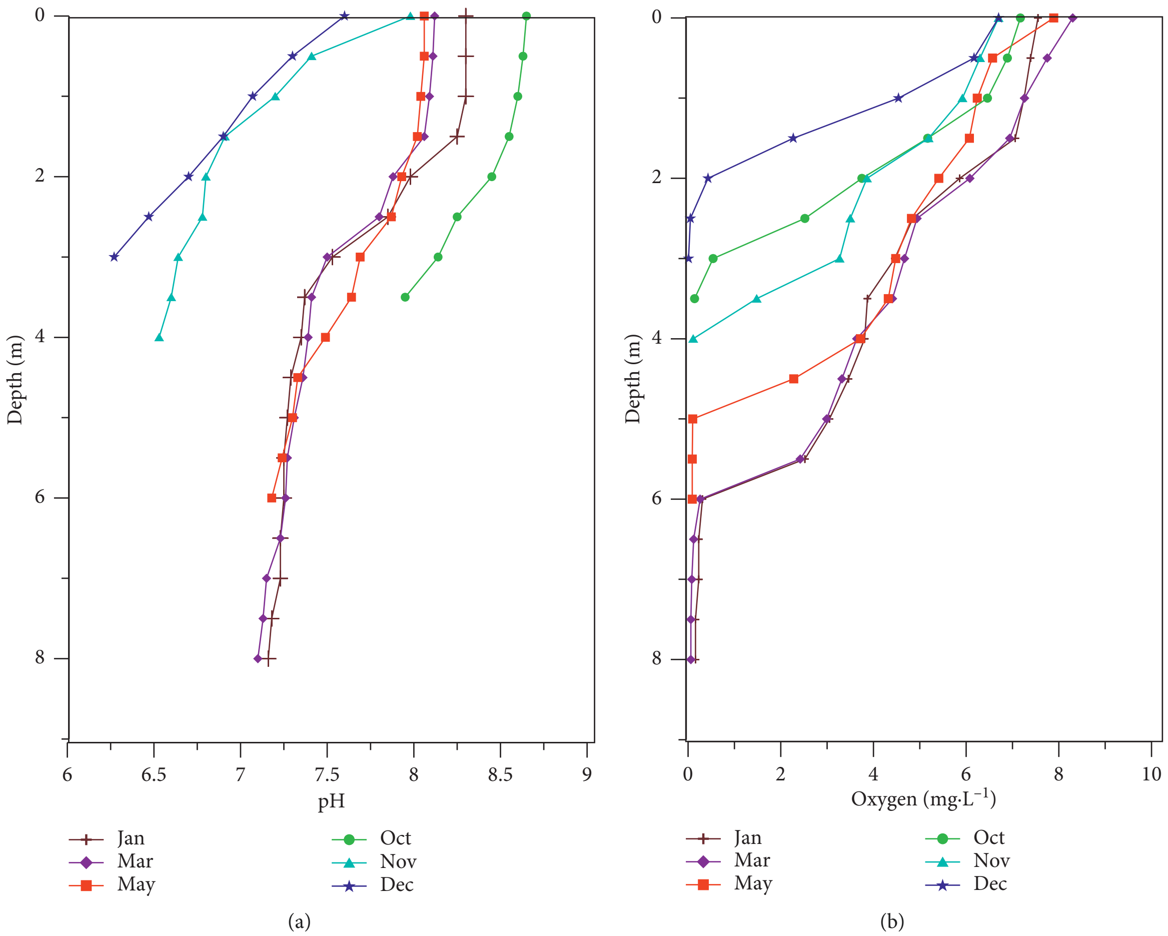
(b)

FIGURE 3: Vertical profiles of temperature and conductivity.

appears to be the phosphate (P) concentrations of surface waters. According to the experimental data collected in this study, reactive phosphate concentrations in the bottom waters are significantly higher than the surface waters, and there is a sharp gradient from the surface to the bottom. The average reactive phosphate concentration expressed as P $\mathrm{mgL^{-1}}$ in the surface waters was $0.054 \pm 0.018\,\mathrm{mgL^{-1}}$, and it was $0.57 \pm 0.16\,\mathrm{mgL^{-1}}$ for the bottom waters. If the entire water column is considered, the average reactive phosphate concentration expressed as P is $0.15\,\mathrm{mgL^{-1}}$. The internationally recommended hypereutrophic status for the total P trigger value is $0.1\,\mathrm{mgL^{-1}}$ [55]. The average reactive phosphate concentration of the Padaviya Reservoir is well above the hypereutrophic trigger value, and the total P concentration of the reservoir is expected to be much higher than the hypereutrophic trigger value. Although Padaviya Reservoir exceeds the hypereutrophic trigger level for total P, dense algal blooms, which are commonly associated with eutrophic/hypereutrophic reservoirs, were not observed at any time of the study period. The experimental data collected from this study does not shed any light to explain the absence of dense algal blooms in the reservoir. The most probable reason is that the Padaviya is a nitrogen-limiting reservoir and total nitrogen and phosphorus data are required to confirm this hypothesis.

Processes leading to P release to the water column from underlying sediments are numerous and include desorption and dissolution of P bound in precipitates and inorganic material [56–58]. The conventional explanation for the release of P from anaerobic profundal lake sediments is the reduction of phosphate-containing Fe oxides, with the resulting diffusion of Fe (II) and phosphate from sediment pore water to overlaying water [59]. Besides, dissolved oxygen, pH, and redox potential at the sediment-water interface can affect the P release from sediments [17, 52, 53, 60, 61].

3.5. Pearson Correlation for Water Quality Factors. Pearson correlation between water quality parameters for surface waters is shown in Table 1. The pH value of the reservoir was negatively related to various water quality parameters. The correlated factors which play an important role in the descending order of the negative value of the correlation coefficient were as ammonia > nitrate > nitrite > reactive phosphate. In addition, conductivity, dissolved oxygen, temperature were positively correlated with pH in the order of conductivity > dissolved oxygen > temperature. The water temperature was negatively related to different quality parameters of water. The main correlated factors in



(a) (b)

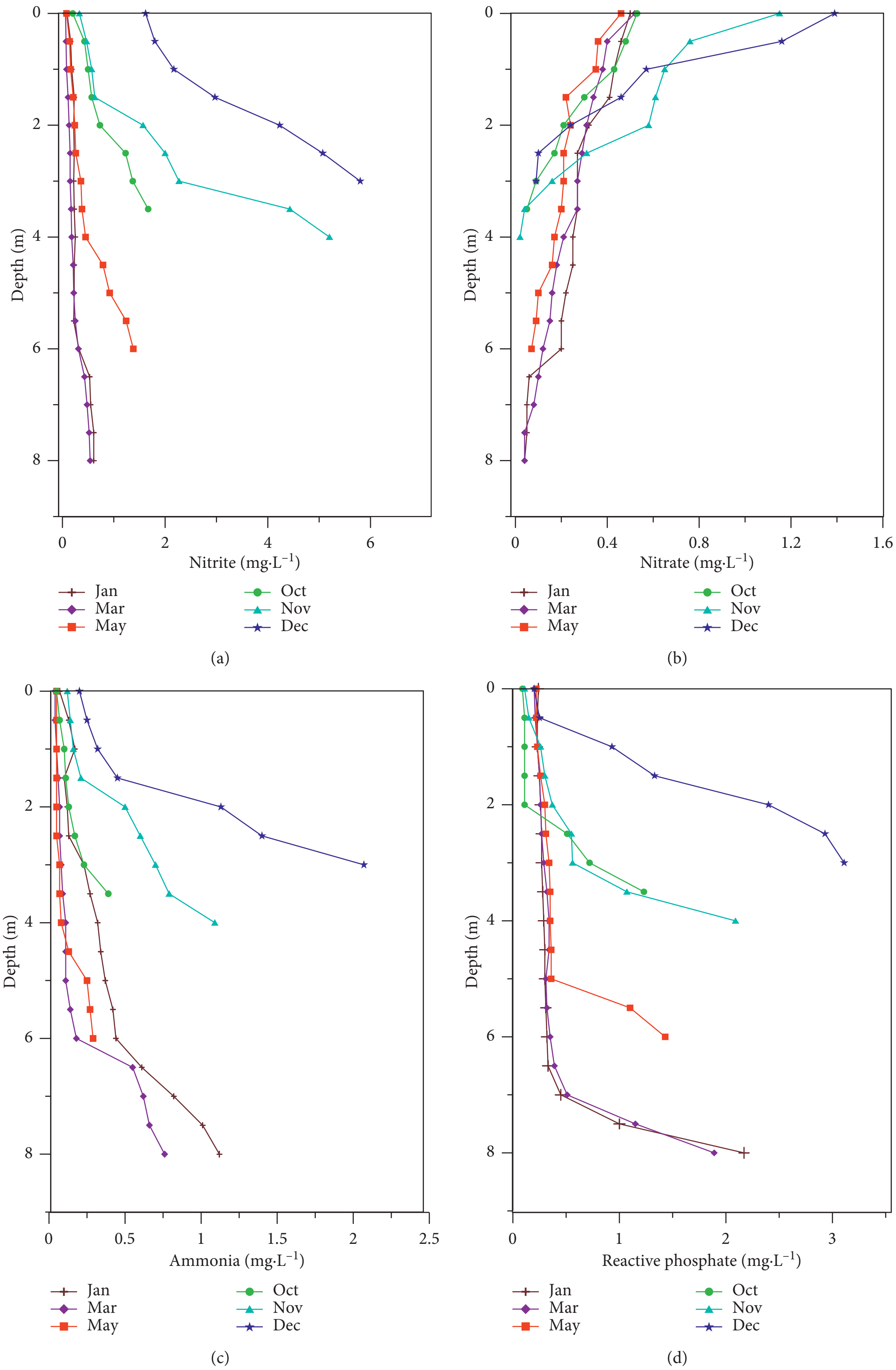
Figure 4: Vertical profiles of pH and DO.

the descending order of the negative value of the correlation coefficient were nitrite > ammonia. Dissolved oxygen concentration was negatively related to various water quality parameters. The main correlated factors in the descending order of the negative value of the correlation coefficient were as nitrate > ammonia > nitrite. The temporal variation of ammonia was positively related to nitrate > nitrite. It indicates an increase of nitrogen species with the period indicating increased sediment decomposition.

Pearson's correlation between bottom water quality parameters is shown in Table 2. Temporal water pH was negatively related to multiple water quality factors. The main correlated factors in the descending order of the negative value of the correlation coefficient were ammonia > reactive phosphate, whereas nitrite and dissolved oxygen positively correlated in the order of nitrite > dissolved oxygen. DO is positively correlated because increased organic matter decomposition has decreased DO in the bottom layer making it anoxic throughout the year. Temporal water temperature was negatively related to nitrite. Temporal variation of DO was negatively related to multiple water quality factors. The main correlated factors in the descending order of the negative value of the correlation coefficient were nitrate > reactive phosphate > ammonia > nitrite. The main reason for dissolved oxygen negatively relating to nitrogen species and reactive phosphate is the increased rate of release of these nutrients under anoxic bottom conditions. Temporal variation of ammonia was positively related to reactive phosphate > nitrite. It indicates an increase of nitrite and reactive phosphate release from bottom sediment decomposition.

3.6. *Principal Component Analysis of Surface Waters.*

PCA analysis of water quality parameters is shown in Table 3. Four components showed 97.7% of the variance in the data set as the eigenvectors classified the eight physicochemical parameters into four groups. The first component (PC1) pH, temperature, and DO accounted for over 54% of the total variance in the data set. In other words, the pH, temperature, DO account for similar patterns seen in lake water samples. This group of nutrient parameters also reflected the degree of eutrophication and organic pollution of the lake. The second component (PC2) included pH and conductivity. This component accounted for 24.8% of the total variance measured. The third and fourth components (PC3 and PC4) included the parameters, ammonium, reactive phosphorous, nitrate, and nitrite, which demonstrated 15.3% and 3% of the total variance, respectively [62].



(a) (b) (c) (d)

FIGURE 5: Vertical concentration profiles of nitrite, nitrate, ammonia, and reactive phosphate.

Table 1: Pearson's correlation coefficient for surface water quality parameters.

	pH	Temperature	Conductivity	DO	Ammonia	Phosphate	Nitrite
Temperature	0.305						
Conductivity	0.433	−0.274					
DO	0.299	0.248	−0.271				
Ammonia	−0.779	−0.552	−0.075	−0.781			
Phosphate	−0.373	−0.271	−0.482	0.511	−0.007		
Nitrate	−0.757	−0.348	−0.124	−0.811	0.956	−0.213	
Nitrite	−0.725	−0.772	0.094	−0.643	0.938	0.048	0.851

Table 2: Pearson's correlation coefficient for bottom water quality parameters.

	pH	Temperature	Conductivity	DO	Ammonia	Phosphate	Nitrite
Temperature	−0.177						
Conductivity	−0.261	−0.283					
DO	0.647	0.401	−0.371				
Ammonia	−0.806	0.151	−0.593	−0.551			
Phosphate	−0.858	−0.166	0.480	−0.606	0.986		
Nitrate	−0.198	−0.832	0.514	−0.626	0.344	0.362	
Nitrite	0.752	0.237	0.730	−0.508	0.703	0.653	0.229

Table 3: Principal component analysis of surface water: pH, temperature, conductivity, dissolved oxygen, ammonia, reactive phosphate, nitrate, and nitrite.

Variable	PC1	PC2	PC3	PC4
pH	0.370	0.371	0.166	0.612
Temperature	0.290	0.041	−0.688	−0.411
Conductivity	0.007	0.560	0.475	−0.623
DO	0.364	−0.378	0.211	−0.235
Ammonia	−0.476	−0.019	−0.060	0.067
Phosphate	0.013	−0.633	0.325	−0.081
Nitrate	−0.454	0.049	−0.273	0.003
Nitrite	−0.463	−0.012	0.214	−0.036

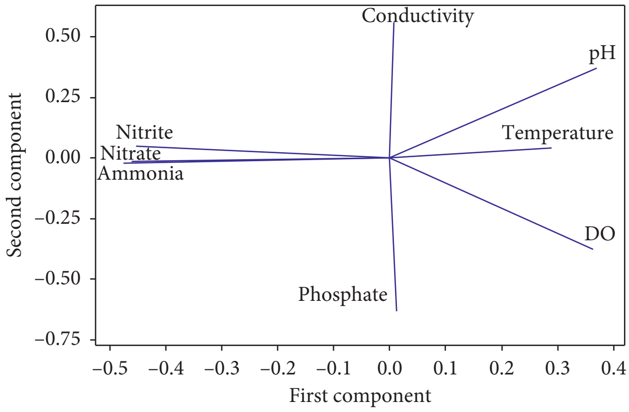


Figure 6: Component loadings for the first component and the second component for surface water.

In the loading plot, as shown in Figure 6, conductivity, pH, temperature, dissolved oxygen, and reactive phosphate have large positive loadings on PC1, and therefore, it primarily measures surface water quality of the reservoir. Nitrate, nitrite, and ammonium have small negative loadings on PC2.

Table 4: Principal component analysis of bottom water: pH, temperature, conductivity, dissolved oxygen, ammonia, reactive phosphate, nitrate, and nitrite.

Variable	PC1	PC2	PC3	PC4
pH	0.387	−0.312	0.353	−0.129
Temperature	0.128	0.674	0.105	0.250
Conductivity	−0.329	−0.115	0.742	−0.044
DO	0.367	0.170	0.343	−0.589
Ammonia	−0.431	0.129	−0.054	−0.488
Phosphate	−0.429	0.121	−0.220	−0.434
Nitrate	−0.277	−0.542	0.017	0.175
Nitrite	−0.380	0.285	0.381	0.340

3.7. Principal Component Analysis of Bottom Waters. PCA analysis of bottom water quality parameters is shown in Table 4. Four components of PCA analysis showed 98% of the variance in the data set as the eigenvectors classified the eight physiochemical parameters into four groups. The first component (PC1) included nutrient parameters pH, temperature, and DO, which accounted for over 56% of the total variance in the data set. In other words, the nutrient parameters pH, temperature, DO account for the similar patterns seen in lake water samples. This group of nutrient parameters also reflected the degree of eutrophication and organic pollution of the lake. The second component (PC2) included temperature, ammonium, and nitrite. This component accounted for 24.3% of the total variance measured. The third and fourth components (PC3 and PC4) included conductivity, reactive phosphate, and nitrate which demonstrated 10.8% and 6.5% of the total variance, respectively [62].

The loading plot as shown in Figure 7 indicated that temperature oxygen and pH have large positive loadings on PC1, so this component primarily measures bottom water

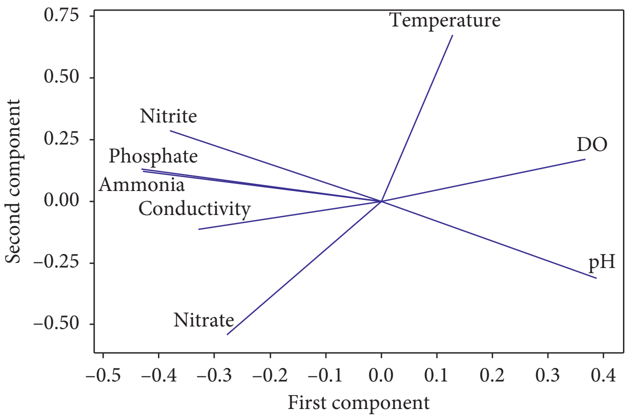


Figure 7: Component loadings for the first component and the second component for bottom water.

quality of the reservoir. Nitrate and nitrite conductivity and ammonium have small negative loadings on PC2.

4. Conclusions

The significantly large difference in conductivity between the surface and bottom waters and sharp chemical gradients observed in the Padaviya Reservoir suggest high bottom loading form the sediment. The temperature difference between the surface and bottom waters of the reservoir is not large enough to cause thermal stratification. Clinograde-type distribution was observed for dissolved oxygen where the well-oxygenated waters were observed at the surface, and oxygen-depleted anoxic waters were observed at the bottom. Hypolimnetic anoxia occurs when respiring microorganisms biodegrade organic matter, predominately phytoplankton biomass and humic substances from well-grown grass and shrubs inundated by the monsoonal rains prevailing in this part of the country between November and December which has sunk into the hypolimnion. In addition, low rates of mixing and turbulence at the sediment-water interface can result in the formation of a thick diffusive boundary layer that impedes diffusion of oxygen into sediments. The anoxic, oxygen-depleted conditions in bottom layers support the presence of reduced nitrogen species, nitrite, and ammonia. Ammonia release from lake sediments typically occurs under anaerobic conditions because of low rates of biological nitrification and ammonia assimilation. The accumulation of reactive phosphate at the bottom waters is also due to phosphate loading from the bottom sediment. In Sri Lanka, many activities around reservoirs generate substantial revenue to the people. However, those activities are not well monitored and if proper measures are not put in place, it will be a major cause of environmental degradation and water resource contamination. As a result, it is very important to monitor water quality changes and trends in order to identify threats to these natural systems. Because of the lack of water quality data in Sri Lankan reservoirs, it is very difficult to establish long-term water quality variability trends, which is essential for reservoir management. Therefore, the data collected in this project will help as the basis to establish long-term water quality monitoring programs that would enable us to manage the reservoirs properly.

Data Availability

Raw water quality data in the Padaviya Reservoir are available at https://doi.org/10.17632/jjst3r7z5y.1.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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Supplementary Materials

Supplementary data contain the average water quality data of the Padaviya Reservoir for the year 2016. The water samples were collected from three locations, as shown in Figure 2, and the averaged water quality data are provided. All the analyses were duplicated. (*Supplementary Materials*)

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