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Assessment of Surface Water Quality by Evaluating the Physico-Chemical Parameters and Identify the Impacts of Water Pollution

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Abstract:
Lunawa lagoon is situated about 19Km from Colombo city. It is about 2500m in length and about 100-250m in width. The lagoon is one of small wetlands site in Sri Lanka. In present the lagoon environment has become deteriorated by human and natural phenomena. The Lunawa lagoon and its catchment area in Rathmalana are compacted with various industrial zones and homestead. It has therefore become necessary to assess the quality of water in the lagoon and the surrounding fresh water aquifer. This lagoon was a main source of fishery before 1980's. There are three main cannels directly connected to the lagoon, Elu Ela, Lunawa Ela, Hemin galena Ela. Surface water quality in this region is largely determined both by natural processes (weathering and soil erosion) and by anthropogenic inputs (municipal and industrial waste water discharge). The objectives of this study have been evaluated the surface water quality in terms of physiochemical parameters of the Lunawa lagoon. Beside this, the work also highlights and draws attention towards the correlation with rainfall and the water quality index. Some physical parameters measured in situ and some selected chemical parameters were done in laboratories. Water quality was surveyed from October 2015 to March 2016 by using at eight different sample points. A total of six water quality parameters namely, water temperature, pH, Electrical Conductivity (EC), Dissolve Oxygen (DO), Salinity, Turbidity were measured in-situ. While for laboratory analysis there were five chemical parameters namely, nitrate, phosphate, Total Dissolve Solids (TDS), Biological chemical oxygen demand (BOD), and Chemical oxygen demand (COD). Along with this work identified the major impacts of water pollution in the lagoon. According to the results, the results of various water quality parameters of the Lunawa lagoon considerably fluctuation in pH among 8 sample points. The pH level range falls into 7.1-7.7. The average range of EC was 3µs/cm-32µs/cm. TDS were recoded high values in stagnant water locations. Water Temperature was having an average 29.4°c – 29.6°c respectively. DO average level was 1.4mg/l – 3.2mg/l across the sites. Turbidity range was 27.4NTU-7.3ntu respectively. The salinity average range was 10.4ppm-28.4ppm. The nitrate concentration was high in the southern part and the phosphate concentration was high in the northern part of lagoon. The BOD and COD in pure water should be within 15mg/l-30mg/l and 3mg/l-5mg/l, but average in the lagoon was 281.81mg/l and 44.81mg/l respectively. There were high negative correlations between pH and rainfall (r = -0.81), EC / rainfall (r = -0.83) and high positive correlation between turbidity / rainfall (r = 0.99), dissolve oxygen / rainfall (r = 0.92). According to the Water Quality Index in the lagoon, water is not suitable for drinking, bathing, aquatic and agricultural purposes.

Keywords: *Correlation, interpolation, lunawa lagoon, water quality index, water quality parameters*

1. Introduction

Water is an essential for all kind of living beings. It is an important component of human survival. The fresh water is a fresh commodity. Water quality is considered the main factor controlling health and the state of disease in both man and animals.

Lakes and tanks are known to be ecological barometers of the health of a city as they regulate the micro climate of any urban center. (Benjamin et al. 1996) The quality of surface water in an inland water bodies have a pro-found effect on the ground water table and ground water quality of the nearby aquifers due to existence of direct interactions between surface and ground water. Lagoons are Eco-tons that develop at the interface between coastal, terrestrial and marine eco-systems. On the world scale lagoon systems comprised 13% of earth's coast line.

Lagoons are classified into 3 main types: leaky lagoons, choked lagoons, and restricted lagoons. Leaky lagoons have wide tidal channels, fast currents and unimpaired exchange of water with the ocean. Choked lagoons occur along high energy coastlines and have one or more long narrow channels which restrict water exchange with the ocean. Circulation within this type of lagoon is dominated by wind pat-terns. Restricted lagoons have multiple channels, well defined exchange with the ocean, and tend to show a net seaward transport of water. Wind patterns in restricted lagoons can also cause surface currents to develop, thus helping to transport large volumes of water downwind. Lagoons are very important water bodies providing habitat for a wide range of flora and fauna. It provides a source of plant generic materials for research work Lagoons and the vegetation that occur in them also improve evaporation and transpiration and thereby help stabilize the climate of the areas around them. Vegetation such as mangrove and forested wetlands also serve as wind-breaks and help to dissipate the force and impact of coastal storm surges. (Apau et al.2012)

Lagoons are subjected to various natural processes taking place in the environment, such as hydrological cycle. Storm water run-off and discharge of sewage into the lagoons are two common ways that various nutrients enter the aquatic ecosystems resulting in the death of those systems.

2. Study Area

Lunwa lagoon was one of the beautiful water bodies in Sri Lanka. But now this resource has deteriorated by municipal influences as artificial drains leading to the lagoon. Lunawa lagoon is situated at an altitude of 1.5 meter below the mean sea level, between 6º 46`- 6º 49` north latitude and between 79º 57`- 79º 53` east longitude in the Moratuwa urban area. (Table: 1) The water body of the lagoon has spread about forty hectares.

Temperature (Mean Annual)	**27 ºC (Max-30 ºC Min-24 ºC)**
Rainfall (Mean annual)	2000mm
Climate Zone	Down south west zone
Soil	Red Yellow podzolic with Laterite
Hydrology	Bolgoda lake, Lunawa lagoon, Lunawa canal

Table 1: Study Area and Its Features
Source: Made by Author According to the Details of
Divisional Secretariat in Moratuwa,2016

2.1. Soil Geology

According to the agro-ecology map within the atlas for Sri Lanka the area is categorized as WL for terrain. This agro ecological region is stretched over the whole south western coastline WL for is dominated by red yellow podzolic with soft and hard Laterite and bog and half bog. Bog soils are black to dark grayish brown in color, they have a PH which can vary from 5.5 to 7.5 and are characterized by high organic matter contents of more than 30%. Half bog soils constitute about 37% of the marsh and are black to dark grayish and have a PH rang in from 5.5 to 6.5. These soils contain about 15 to 30 % organic matter (CEA, 1993) Alluvial deposits with fine clay mixed with organic and soft sandy clay with decomposed organic matters 2 to 4 M below the surface, south east of the Galle road in the vicinity of the airport and the area around the Bolgoda lake and Lunawa lagoon. At greater depth 8 to 10 M salt medium clay with gray silty sand has been identified. It is likely that the depth of this clay layer decreases in the area around the Lunawa lagoon. (Lunawa lagoon special area management plan,2005)

2.2. Flora and Fauna

In contrast to most other lagoons in the island, the surroundings of the Lunawa lagoon almost completely covered with urban structures. There are several bare islands but these are not covered by vegetation. However, the lagoon itself is covered with floating, submerged and bottom rooted types of vegetation. The majority of free-floating plants are Eichhornia crassipes (water hyacinth) and Salvinia molesta. Water hyacinth is spreading past in the southern part of the lagoon where the salinity is low as well as in the streams feeding the lagoon. This plant species flourishes specially in water bodies with high levels of nutrients. Since the drains entering the north side of Lunawa of contain high concentrations of untreated influent discharge most of the drains are fully covered with water hyacinth. The Aththidiya bird sanctuary is an important habitat to the birds in the area, which attracts many birds that also visit Lunawa lagoon. In the past Lunaw lagoon also had been famous as a bird watching ground. Apart from the presence of bird, Lunawa lagoon used to be a rich fishing ground that provided livelihood for about 150 families before 1979. During the last fish count in 1994, 22 fish species and six species of crustaceans were recorded in the lagoon. According to the local people living around Lunawa, there is a strong decline over the years in the amount of animal species living in and around the lagoon.

The environmental conditions of any lagoon system depend upon the nature of that lagoon and its exposure to various anthropogenic factors. The lagoon and its main branch canals were with pure water that can be used before four decades. Since 1960, various industries like, clothes, chemicals, metal finishing, confectionary and asbestos were established in Moratuwa - Rathmalana area. (Associated Engineering, 1994) However in recent decades' population growth and sewage run-off from urban areas including flats and slums have increased. Nutrient inputs many folds to the level of their natural occurrence resulting in accelerated eutrophication. As well as heavy metal concentration were exceeded standard limits in coastal water body. (Environmental pollution and its impact on fishery management in Lunawa lagoon, 1994) Most industries in this area discharge their effluents without any pretreatment and this has led to serious pollution problem of surface water in the lagoon.

3. Methodology

The objects of the study have been evaluated the surface water quality in terms of physiochemical parameters of the Lunawa lagoon. Beside this, the work also highlights and draws attention towards the correlation with rainfall and the water quality index in a simplified format which may be used of large and could present the reliable picture of water quality variation regarding to rainfall and also identify the natural and human impacts to the people due to water pollution in the lagoon.

The surface water samples collected at 8 different sites (Figure 1) within the Lunawa lagoon and its main its three canals.

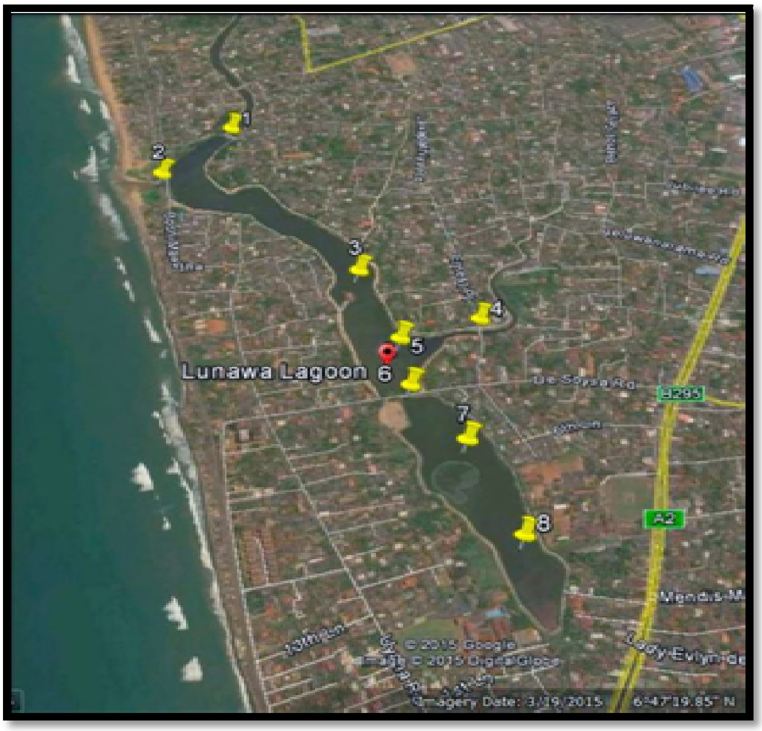


Figure 1: Selected Sample Points in Lunawa Lagoon
Source: Google earth, 2015

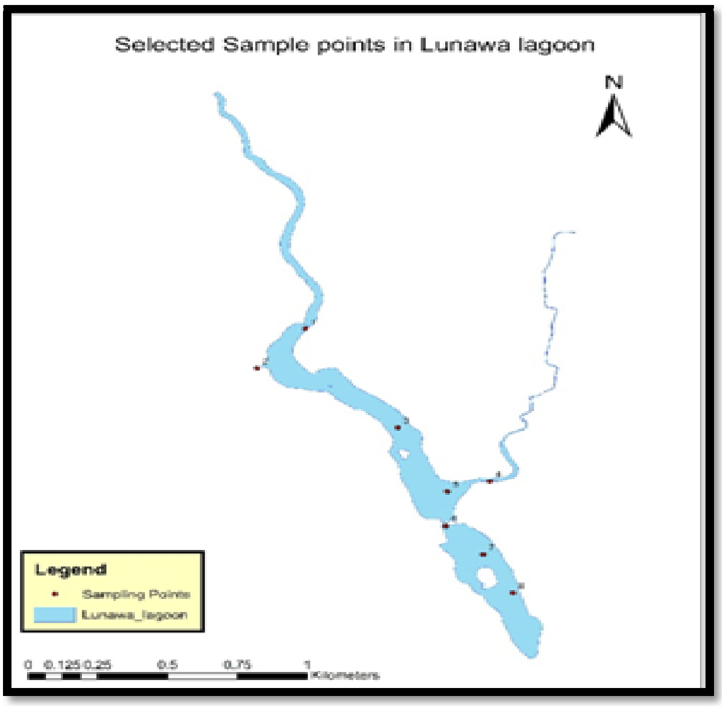


Figure 2
Source: Created by Author Using Geographic Information System, 2016

Those water samples were collected depth wise in each and every sample point. Those points were assigned in canal inlets, lagoon outfall, and stagnant water location and nearby population dense areas. The surface water samples were collected to pre-cleaned plastic bottles for a period of six months from October 2015 to March 2016. This period consists of wet and dry period. Six-month continuous monitoring involved physico-Chemical analysis. In situ parameters like pH, EC, DO, Salinity, turbidity and Temperature were measured immediately in the field by using multi parameter and turbidity meter after sampling. While for laboratory analysis there were five parameters namely Nitrate, Phosphate, TDS, COD and BOD concentration. Monthly changes and spatial changes in various physical and chemical parameters were analyzed. The standard analytical procedures as recommended by Standard method for examination water and waste water (20th edition) and the American public health association (2010). Based on the results of physico- Chemical analysis, made a Water Quality Index by calculating Arithmetic Water Quality Index (WQI) method (for high rainfall intensity month and low rainfall intensity month).

$$Wi = K/\ Si$$

$$k = \frac{1}{\sum\left(\frac{1}{s_i}\right)}$$

(Source: Mukhtar et al., 2014)

- Sub Index (SI)

$$SI = Wi\ qi$$

$$WQI = \sum_{i=1}^{n} SI\ i$$

(Source- Ravikumar et al, 2013)

Wi= weight of the i^{th} parameter

SI = Water quality standards using in Sri Lanka

K= Proportionality Constant value

Qi= Water quality

Ci = water quality parameter value of the i^{th} water sample

Analyzed spatial, temporal variation using Geographic information system (GIS) and analyzed correlation between pH, EC, Turbidity, DO and rainfall. Analyzed spatial variation using Invers Distance Interpolation (IDW) IN Arc GIS 10.1 was performed to prepare spatial distribution maps. Analyzed temporal variation and calculated correlation using MS Excel 2013 version to performed data analysis.

4. Results and Findings

pH ranges from 0-14 if the value is below seven ids acidity. And the value is above seven call alkaline (Figure:3). When pH value changes its lead to changes of chemical parameters in water. According to pH standards from 6.5-8.5 suitable for drinking, from 6-8.5 suitable for aquatic lives. And 6-9 range is suitable for bathing and recreational activities. In the spatial distribution, Ph value, slightly higher in southern part of the lagoon. The Ph value is low in point no 1 its located near to the inlet of Lunawa Ela. The results of various water quality parameters of the Lunawa lagoon considerably fluctuation in pH among 8 sample points. There was a high pH values were observed in southern part of the lagoon (Figure 13). The pH level range falls into 7.1-7.7. This limit within the WHO pH levels.

The average of EC level considerably high in low rainfall intensity months. The average range of EC was 3µs/cm-32µs/cm.

Total dissolved solids value has increased because of mud and natural materials if the dissolved solids are high positive and negative irons will be increased. During the sampling period, the lagoon outfall has been closed by sand, therefore the lagoon water had been stagnant so the TDS levels were increased in many sample locations. In the two canal outlets, the TDS levels considerably low. In the location no.04 TDS levels was high in December, January and February. Figure:4) Because the sampling seasons of above months were in dry condition. As well as the flow of Elu ela normally 0.09 cubic meter. When consider about of TDS, it recorded high values in southern part because of the poor water circulation in the lagoon (Figure 14).

Water Temperature were having an average 29.4°c – 29.6°c respectively (Figure: 5).

DO average level was 1.4mg/l – 3.2mg/l across the sites. Respectively the DO level in lagoon outfall was lower than other sites. Because the salinity level recoded high in the outfall. This DO level not enough to the aquatic lives in the lagoon. The oxygen content is decrease with increase in water temperature. It has negative impact on organic waste processing by the aerobic micro-organisms. Therefore, the lagoon has become dead. Normally the oxygen level in water decrease due to high bacterial activities and high Bio-chemical and Chemical oxygen demand. In the study area in point no. 02 and 04 DO levels has been decreased because in October, February and March lagoon outfall had been opened (Figure:6). Therefore, marine water mixed with lagoon water and salinity level has been increased. In point no. 08, DO recorded low values, because of water hyacinth has spread in this area. Therefore, after decomposition, anaerobic condition arises. An also in point no. 04 DO level was higher than other points (Figure 16)

Turbidity means clearances of water. Turbidity range was 27.4 NTU-7.3 NTU respectively. This level was higher than WHO standard limit. So, the current situation not suitable for the aquatic. In high intensity rainfall months' turbidity level, increased (Figure:7). According to spatial variation point no.01 and 05 recorded high turbidity levels. In southern part the turbidity levels were higher than northern part of the lagoon (Figure 16)

The salinity average range was 10.4ppm-28.4ppm. The salinity level was normally high in point no.02. In point no.01 and 04 salinity levels were lower than other points (Figure:8). Because of these places, canals have connected to the lagoon (Figure 20). Normally in bottom level salinity levels lower than upper levels.

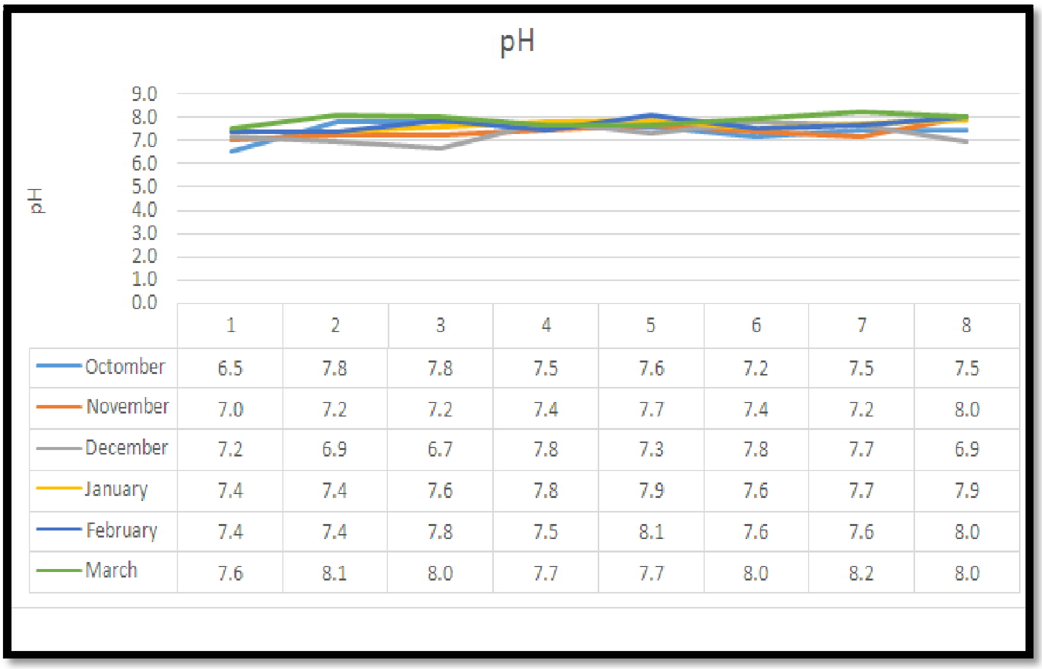
The nitrate concentration was high in the southern part. In October point no. 01, 04 and 08 have recorded high nitrate values (Figure:9). These locations are Lunawa ela inlet, Elu ela and water hyacinth dense area. But could not identify the eutrophication condition (Figure 18).

The phosphate concentration was high in the northern part of lagoon. In point no.01 and 04 the phosphate values have increased in all months (Figure:10). As well as the phosphate concentration was high in some locations than WHO standards (Figure 19).

The BOD and COD in pure water should be within 15mg/l-30mg/l and 3mg/l-5mg/l, but average in the lagoon was 281.81mg/l and 44.81mg/l respectively. In this study, checked this parameter only in two months November and march. The biochemical oxygen demand was high in point ni.01 and 04. As well as in November the BOD levels higher than March (Figure:11). The reasons for these results, November was a rainy month and March was a dry month in that period. The significant thing was the levels of BOD records beyond the standards levels.

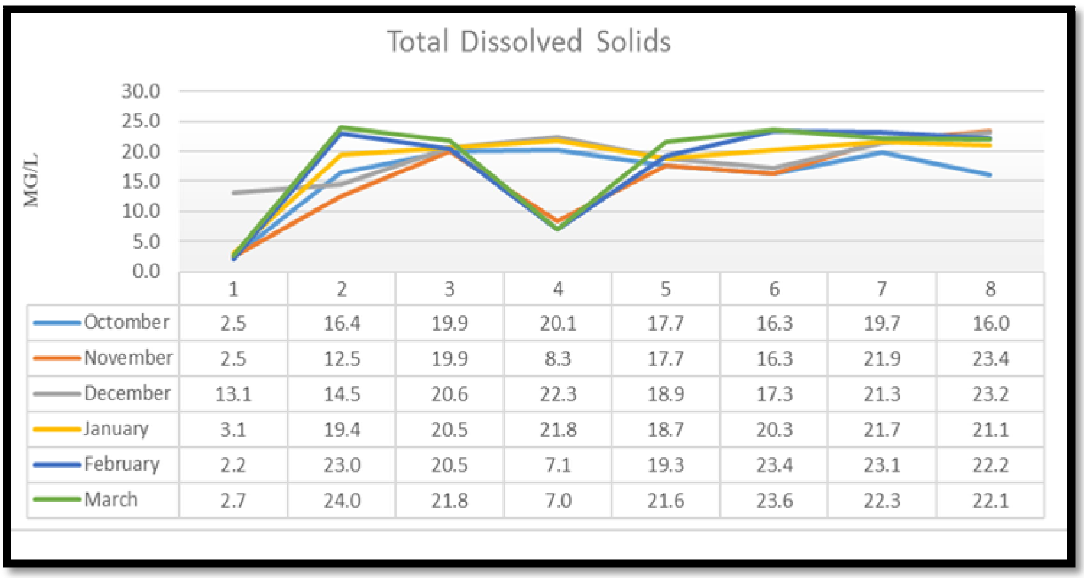
COD is widely used for determining waste concentration and is applied primarily to pollutant mixtures such as domestic sewage and industrial waste. In point no. 01,04 and 05 COD levels have recorded high values in both months Figure:12). COD levels also beyond the standards.

The graphical depiction for various water quality parameter is given as:



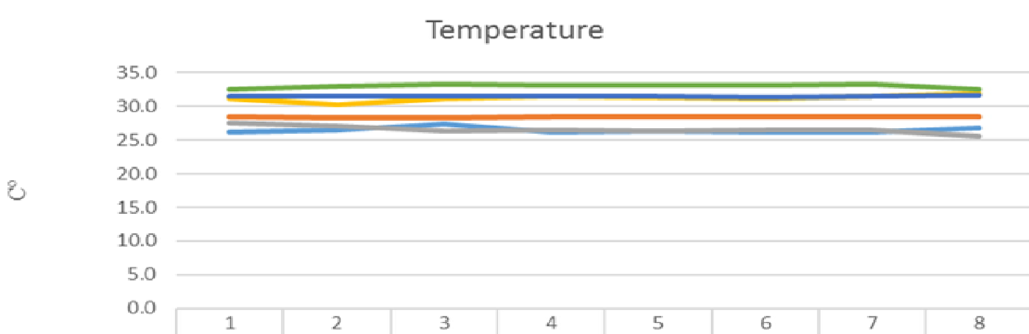
	1	2	3	4	5	6	7	8
Octomber	6.5	7.8	7.8	7.5	7.6	7.2	7.5	7.5
November	7.0	7.2	7.2	7.4	7.7	7.4	7.2	8.0
December	7.2	6.9	6.7	7.8	7.3	7.8	7.7	6.9
January	7.4	7.4	7.6	7.8	7.9	7.6	7.7	7.9
February	7.4	7.4	7.8	7.5	8.1	7.6	7.6	8.0
March	7.6	8.1	8.0	7.7	7.7	8.0	8.2	8.0

Figure 3: Temporal Variation of Ph Levels in the Selected Sample Points



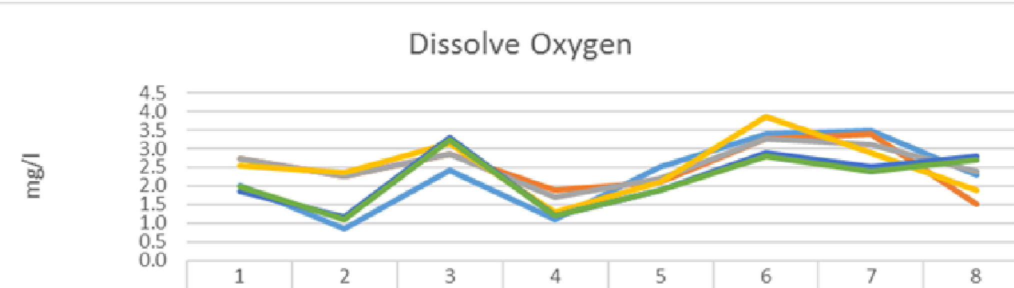
	1	2	3	4	5	6	7	8
Octomber	2.5	16.4	19.9	20.1	17.7	16.3	19.7	16.0
November	2.5	12.5	19.9	8.3	17.7	16.3	21.9	23.4
December	13.1	14.5	20.6	22.3	18.9	17.3	21.3	23.2
January	3.1	19.4	20.5	21.8	18.7	20.3	21.7	21.1
February	2.2	23.0	20.5	7.1	19.3	23.4	23.1	22.2
March	2.7	24.0	21.8	7.0	21.6	23.6	22.3	22.1

Figure 4: Temporal Variation of Total Dissolved Solids Levels in the Selected Sample Points



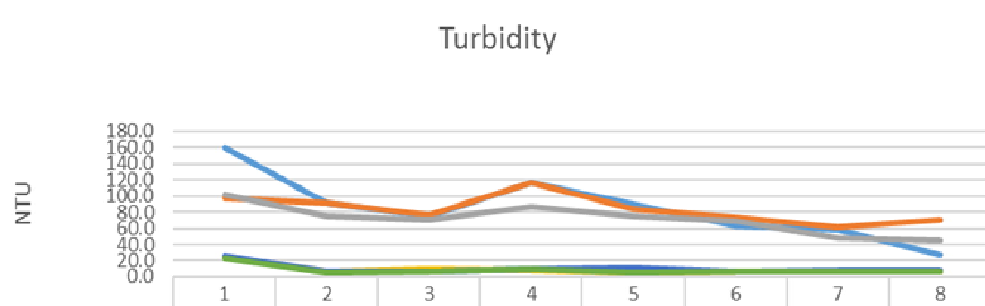
	1	2	3	4	5	6	7	8
Octomber	26.1	26.4	27.4	26.2	26.4	26.1	26.2	26.8
November	28.4	28.3	28.3	28.4	28.5	28.4	28.4	28.5
December	27.6	27.1	26.3	26.5	26.3	26.4	26.5	25.5
January	31.1	30.3	31.2	31.4	31.3	31.2	31.4	32.0
February	31.5	31.4	31.4	31.5	31.5	31.4	31.4	31.6
March	32.5	33.1	33.3	33.2	33.1	33.2	33.3	32.6

Figure 5: Temporal Variation of Temperature Levels in the Selected Sample Points



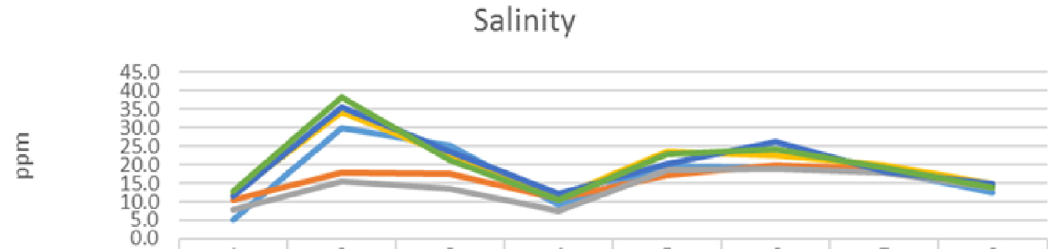
	1	2	3	4	5	6	7	8
Octomber	2.0	0.9	2.4	1.1	2.5	3.4	3.5	2.3
November	2.7	2.3	2.9	1.9	2.1	3.3	3.4	1.5
December	2.7	2.3	2.9	1.7	2.2	3.3	3.1	2.4
January	2.5	2.4	3.1	1.3	2.1	3.9	2.9	1.9
February	1.8	1.2	3.3	1.2	1.9	2.9	2.5	2.8
March	2.0	1.1	3.2	1.2	1.9	2.8	2.4	2.7

Figure 6: Temporal Variation of Dissolve Oxygen Levels in the Selected Sample Points



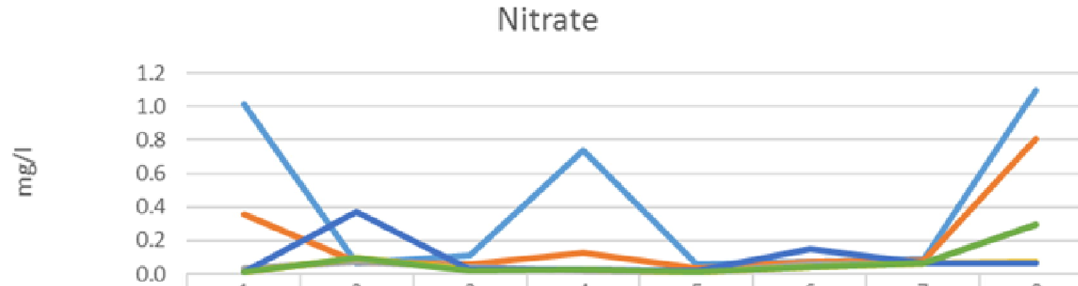
	1	2	3	4	5	6	7	8
Octomber	159.9	91.1	75.3	117.0	89.5	63.7	58.1	27.3
November	97.5	91.2	75.8	116.9	83.1	74.0	61.2	70.9
December	102.1	75.6	70.9	86.8	75.4	68.7	48.3	45.5
January	23.7	6.8	8.8	8.2	5.6	7.0	5.9	7.1
February	26.5	6.1	6.0	9.7	10.3	6.9	7.3	7.2
March	22.3	5.3	5.8	8.8	5.4	6.1	7.2	6.4

Figure 7: Temporal Variation of Turbidity Levels in the Selected Sample Points



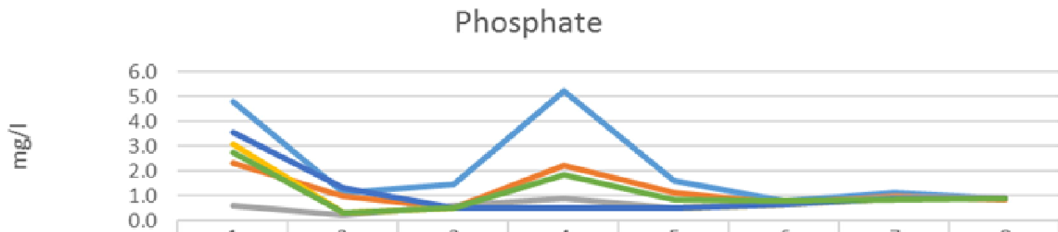
	1	2	3	4	5	6	7	8
Octomber	5.1	29.9	25.3	9.3	19.4	19.1	18.4	12.4
November	10.6	18.0	17.5	10.7	17.3	19.7	18.7	14.2
December	7.9	15.7	13.4	7.5	18.4	18.7	17.9	13.8
January	12.3	34.2	22.4	11.2	23.4	22.4	19.7	14.8
February	11.5	35.7	23.4	12.2	20.1	26.4	18.2	14.9
March	12.9	38.1	21.2	10.5	22.8	24.3	19.3	13.9

Figure 8: Temporal Variation of Salinity Levels in the Selected Sample Points



	1	2	3	4	5	6	7	8
Octomber	1.0	0.1	0.1	0.7	0.1	0.1	0.1	1.1
November	0.4	0.1	0.1	0.1	0.0	0.1	0.1	0.8
December	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.3
January	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1
February	0.0	0.4	0.0	0.0	0.0	0.1	0.1	0.1
March	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.3

Figure 9: Temporal Variation of Nitrate Levels in the Selected Sample Points



	1	2	3	4	5	6	7	8
Octomber	4.8	1.1	1.5	5.2	1.6	0.8	1.1	0.9
November	2.3	1.0	0.5	2.2	1.1	0.7	1.0	0.9
December	0.6	0.2	0.6	0.9	0.5	0.7	0.9	0.9
January	3.1	0.3	0.5	0.5	0.5	0.6	0.9	0.9
February	3.6	1.3	0.5	0.5	0.5	0.6	0.9	0.9
March	2.8	0.3	0.5	1.8	0.9	0.8	0.9	0.9

Figure 10: Temporal Variation of Phosphate Levels in the Selected Sample Points

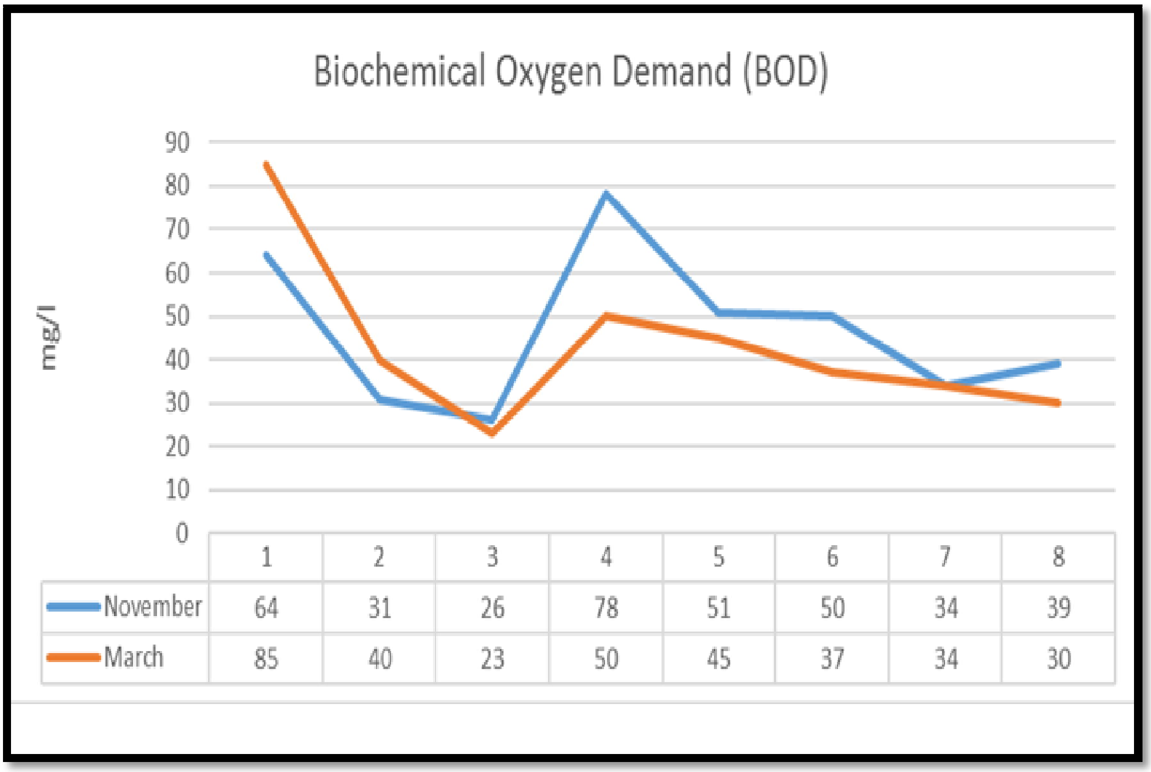


Figure 11: Temporal Variation of Biochemical Oxygen Demand Levels in the Selected Sample Points

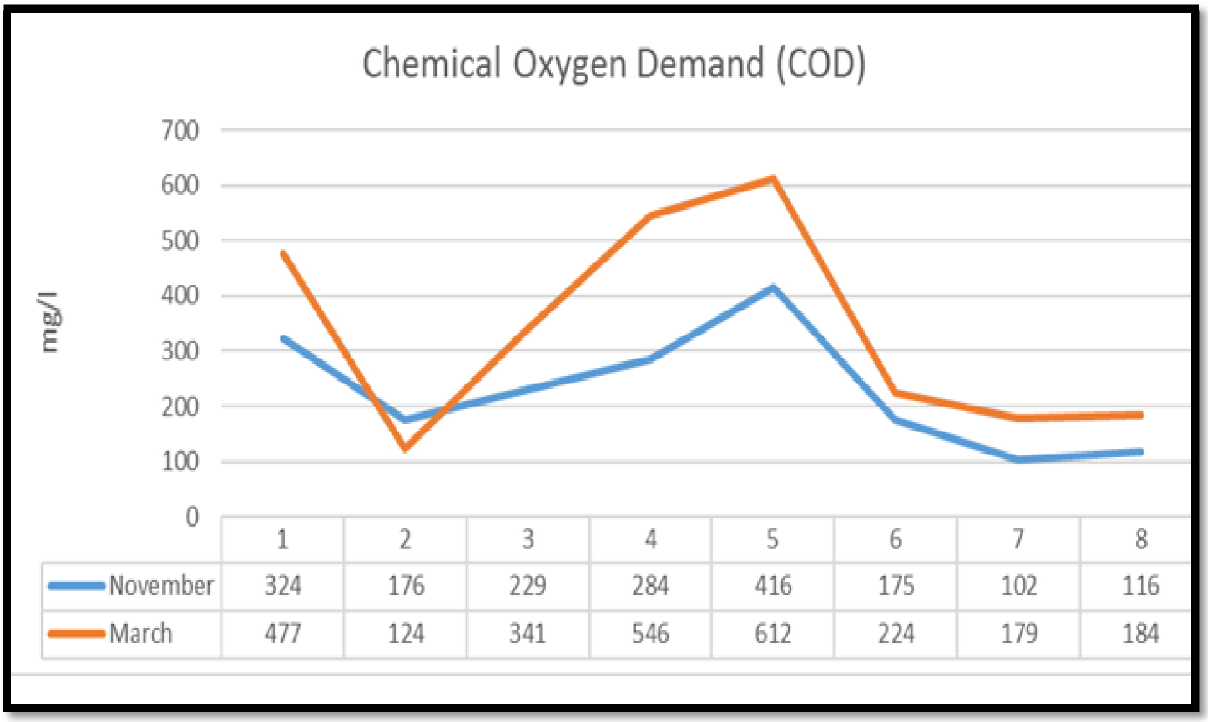


Figure 12: Temporal Variation of Chemical Oxygen Demand Levels in the Selected Sample Points

The maps depiction for various water quality parameters are given as:

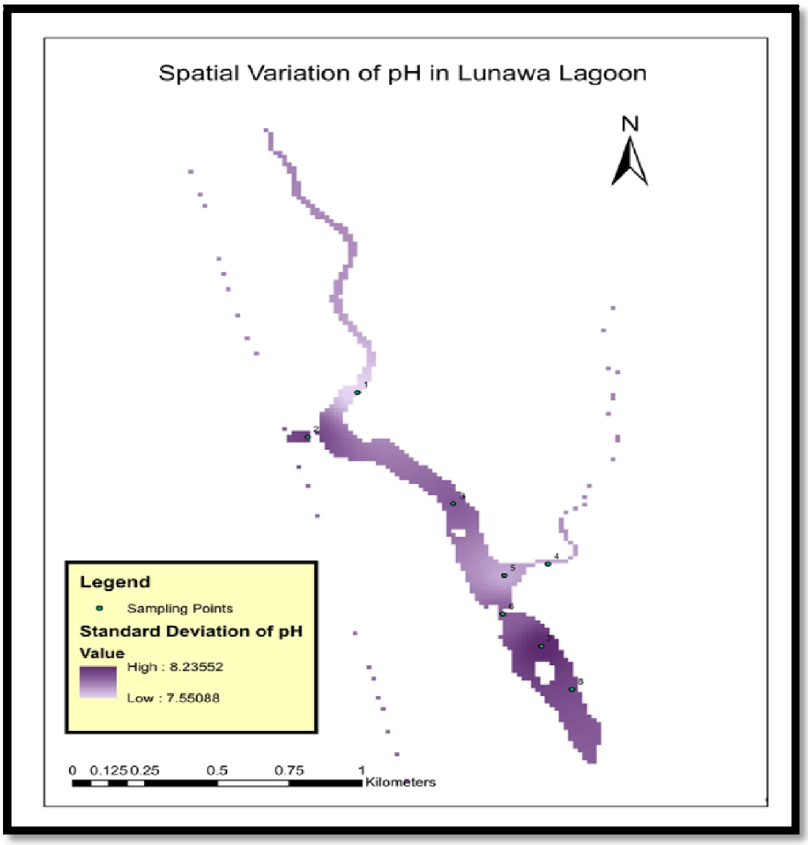


Figure 13
Source: Made by Author, 2016

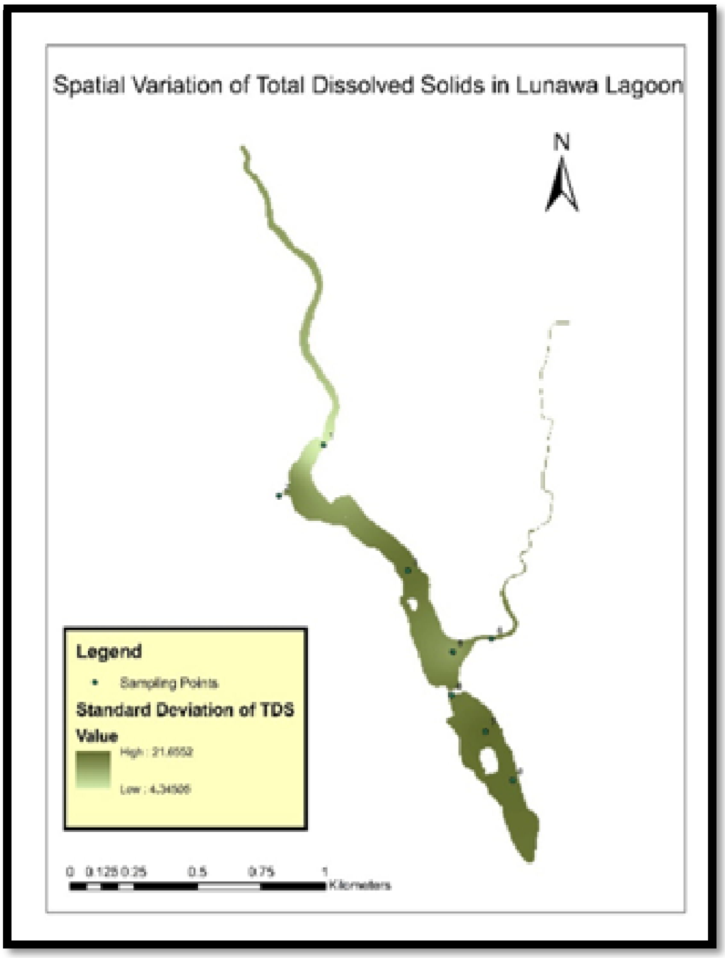


Figure 14
Source: Made by Author, 2016

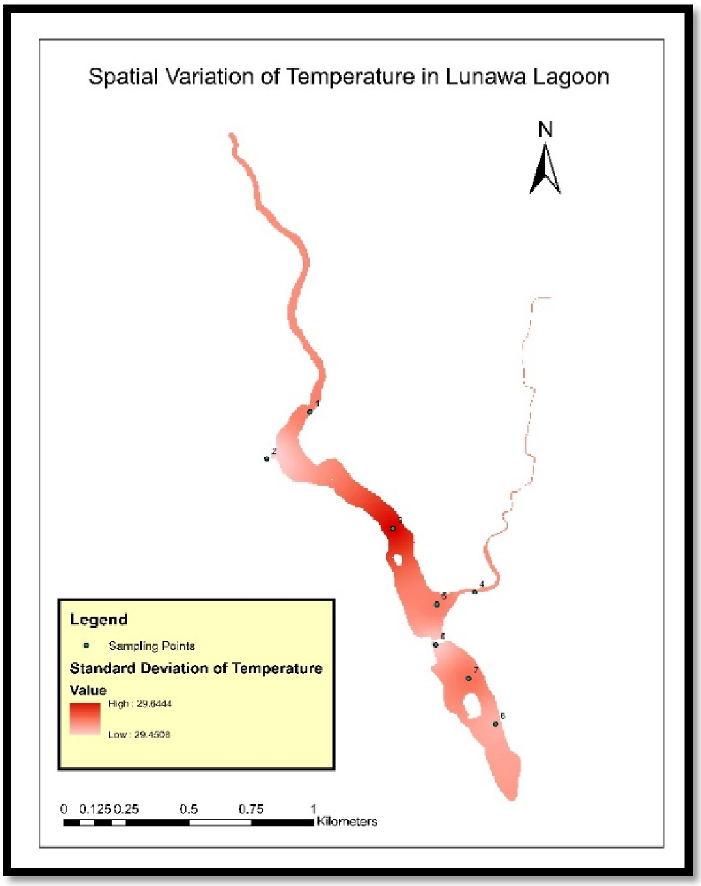


Figure 15
Source: Made by Author, 2016

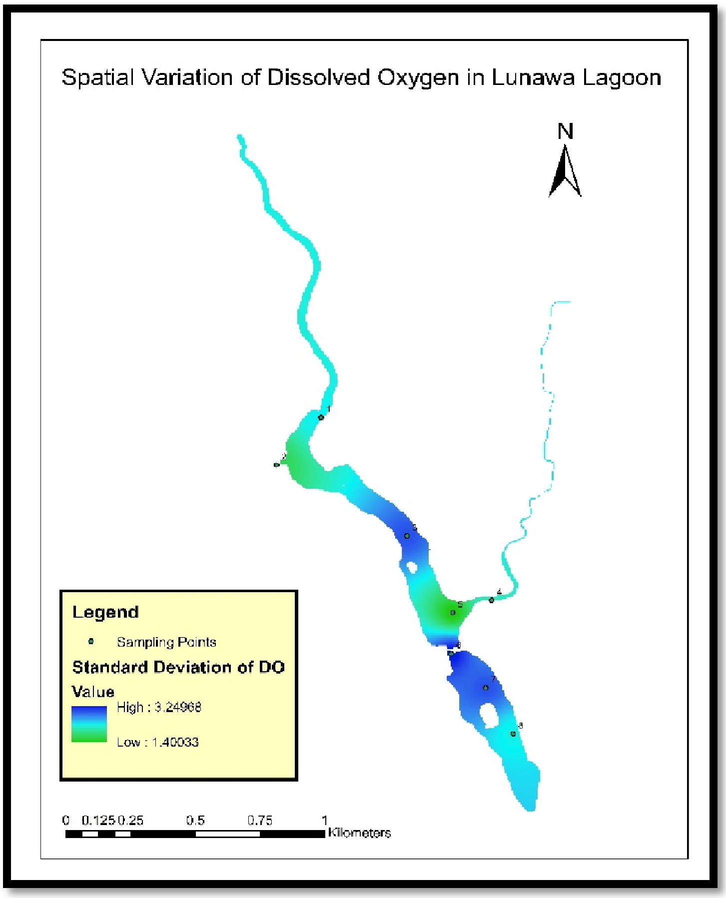


Figure 16
Source: Made by Author, 2016.

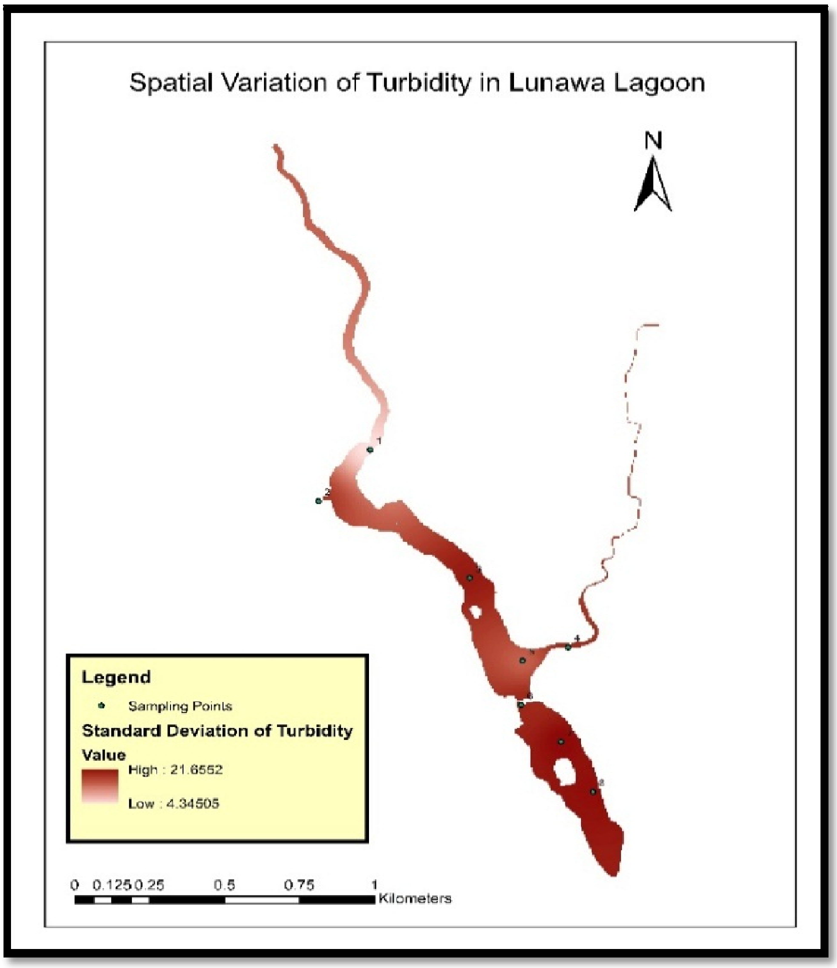


Figure 17
Source: Made by Author, 2016

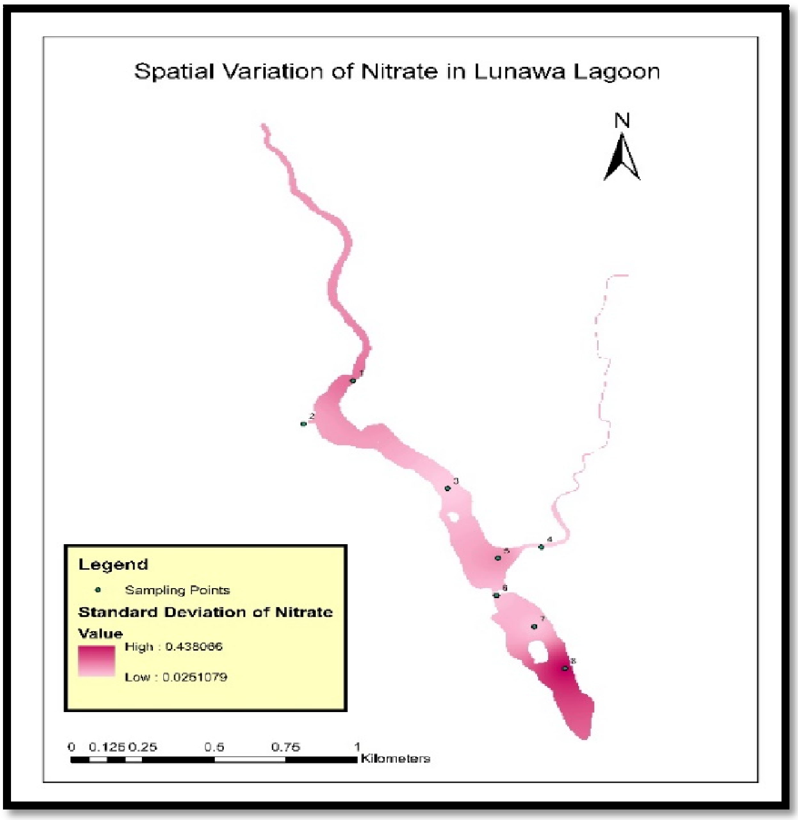


Figure 18
Source: Made by Author, 2016

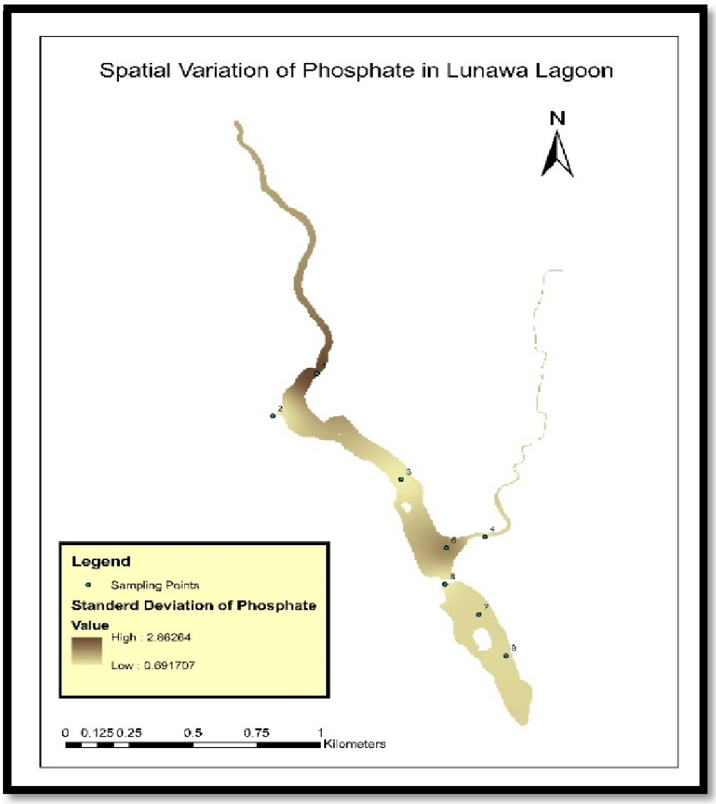


Figure 19
Source: Made by Author, 2016

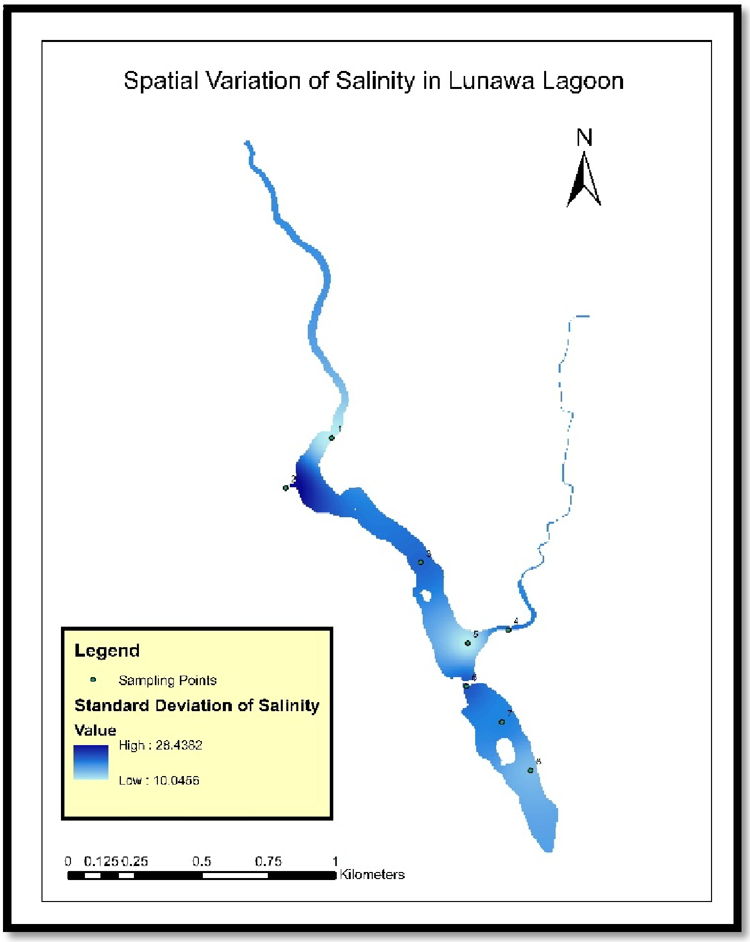


Figure 20
Source: Made by author, 2016

4.1. Water Quality Index

Water quality in water bodies is a complex issue with multiple aspects such as physical, chemical and biological process and their interactions. Water quality index has the capability to reduce the bulk of information in to a single value to express the data in a simplify and logical form. Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables.

Water quality index is defined as a technique of rating that provides the composite influence of individual water equality parameter on the overall quality of water.

WQI Values	Rating of Water Quality	Grade
0 – 50	Very Good	A
50 - 100	Good	B
100 - 200	Poor	C
200 - 300	Very Poor	D
> 300	Unsuitable for drinking, bathing, aquatic and irrigation	E

Table 2

Source- Ravikumar et al, 2013

	si		1/si	k	Wi
pH	6	7	0.166667	0.390132	0.065022
EC	750	0	0.001333	0.390132	0.00052
Turbidity	5	0	0.2	0.390132	0.078026
DO	6	0	0.166667	0.390132	0.065022
Nitrate	5	0	0.2	0.390132	0.078026
Phosphate	0.7	0	1.428571	0.390132	0.557331
BOD	3	0	0.333333	0.390132	0.130044
COD	15	0	0.066667	0.390132	0.026009
			2.563238	0.390132	1

Table 3

	si		1/si	k	wi	ci	ci/si	qi=ci/si*100	si=wi*qi
pH	6	7	0.166667	0.390132	0.065022	7.0	1.166667	116.6667	7.585891
EC	750	0	0.001333	0.390132	0.00052	19.0	0.025333	2.533333	0.001318
Turbidity	5	0	0.2	0.390132	0.078026	72.1	14.42	1442	112.5139
DO	6	0	0.166667	0.390132	0.065022	3.9	0.65	65	4.226425
Nitrate	5	0	0.2	0.390132	0.078026	0.1	0.02	2	0.156053
Phosphate	0.7	0	1.428571	0.390132	0.557331	0.7	1	100	55.73308
BOD	3	0	0.333333	0.390132	0.130044	46.6	15.54	1554	202.0881
COD	15	0	0.066667	0.390132	0.026009	227.8	15.18333	1518.333	39.48998
			2.563238	0.390132	1				421.7948

Table 4

	si		1/si	k	wi	ci	ci/si	qi=ci/si*100	si=wi*qi
pH	6	7	0.166667	0.390132	0.065022	7.9	1.316667	131.6667	8.56122
EC	750	0	0.001333	0.390132	0.00052	28.3	0.037733	3.773333	0.001963
Turbidity	5	0	0.2	0.390132	0.078026	8.4	1.68	168	13.10842
DO	6	0	0.166667	0.390132	0.065022	2.4	0.4	40	2.600877
Nitrate	5	0	0.2	0.390132	0.078026	0.1	0.02	2	0.156053
Phosphate	0.7	0	1.428571	0.390132	0.557331	1.1	1.571429	157.1429	87.58055
BOD	3	0	0.333333	0.390132	0.130044	43	14.33333	1433.333	186.3962
COD	15	0	0.066667	0.390132	0.026009	335.87	22.39133	2239.133	58.2371
			2.563238	0.390132	1				356.6424

Table 5

By employing important physico-chemical parameters like BOD, COD, Nitrate, Phosphate, Dissolve oxygen, Turbidity, EC and pH for which the recommended standard values are available in arithmetic water quality index equation and doing the require simulation for Lunawa lagoon, the water quality values were found to be 421.79 in high rainfall month (Table4) and 356.64 in low rainfall month (Table5). After calculating the Water Quality Index, the lagoon water not suitable for drinking, bathing, aquatic and agricultural purposes. There were high negative correlations between pH / rainfall (r = -0.81), EC / rainfall (r = -0.83) and high positive correlation between turbidity / rainfall (r = 0.99), dissolve oxygen / rainfall (r = 0.92).

The results of impact to the human and natural environment around the lagoon the major thing was decrease aquatic lives. Before 1980's there were 24 fish species and 6 finfish in the lagoon. Lagoon eco system helps to survive the aquatic lives and their life cycles. In present, there are no more fish species, only "Batta" and "Illaya" are remaining. Mangroves also help stabilization of the lagoon eco system. But, in present mangroves were disappeared after Lunawa Environment Improvement and Human development project in 2004.

This lagoon is situated near to the Belanvila- Aththidiya bird sanctuary. But in present bird density decreases in the lagoon area because of water pollution and decreased of mangroves. This lagoon periphery was special place for bird watching ground before 2-3 decades. According to the interviews there were 45 bird species around the lagoon before 1990's. Some of them were migrant birds. According to the bird survey during the study period Crow, Parrot, Kingfish, Heron, Water heron, Hawk, Mina etc. often were recoded.

The other impact was flooding in the area. In this research, four reasons were identified. They were, reduce deep in the lagoon, improperly development, unsystematic drainage system and covered lagoon outfall by sand. Encroachment was highly contribution to reduce the deep of the lagoon. In other hand water born plants were cause for reducing depth in the lagoon.

There were some impacts directly affected to the people. They were, spread illnesses (Such as dengue and skin problems), Decline of fishery, pollution of ground water sources, unsuitable for bathing and water sports and unbecoming for tourism.

5. Conclusion

In this study, different water quality parameters of the surface water in the Lunawa lagoon were evaluated the information drawn from the data reveals that it is possible to formulate viable strategies which could reduce the pollution load of the lagoon water. The main cause of degradation of industrial effluents and municipal sewage. This study helps in identification of pollution sources and understanding variation in water quality for effective water management, interventions like reduction in anthropogenic discharge, rehabilitation of households in the vicinity of the lagoon. Water purification methods, conservation of sensitivity area around the lagoon, restoration mangroves and implement the Moratuwa zoning plan as soon as possible. After implement above implementations the lagoon water will become a usable resource.

6. References

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