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Effects of Uncontrolled Floricultural Farm Activity on Surface Water Quality: Case Study, Dembal Lake, Batu Ethiopia.

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ABSTRACT

The uncontrolled anthropogenic activities have been a serious treat for Surface water quality in developing countries. Floriculture industry is a booming sector in Ethiopia and is spreading throughout the country. The release of hazardous chemicals in the form of fertilizers, pesticides and disposal of untreated wastes which contaminates the water body. Dembal Lake is one of a few fresh water bodies among the Central Rift Valley Lakes. Its economic importance is significantly increasing from time to time. It serves as a fishery resource, small scale and large scale irrigation water supply, drinking water supply for Batu City, and many other uses. Dembal Lake in Batu city has been a discharge point of effluent from surrounded floriculture farms. This study was carried out to evaluate the effects of uncontrolled floricultural farm activity on the surface water quality of the Lake. About five sites were chosen purposively from various points such as upstream, middle stream, lower stream and pristine lake environment. The pristine site which was selected at the upstream was used as a control. A total of 45 samples were tested for physico-chemical, oxygen demanding, and nutrient parameters. The results were analyzed using SPSS and excel software to see if there were significant differences between the control and other sampling sites. EC, TDS, BOD, COD, NO_3^-, and PO_4^{3-} showed significant difference ($P<0.05$) between the control and other sampling sites. The result showed an increasing trends of TDS (350.1 ± 83.5 to 570.7 ± 175.5), EC (0.65 ± 0.045 to 2.24 ± 0.3), PH (8.7 ± 0.22 to 8.9 ± 0.5), and COD (96.4 ± 3.5 to 127.5 ± 6.34), BOD (17.3 ± 1.16 to 23.34 ± 7.52), NO_3^- (2.88 ± 2.35 to 52.5 ± 19.35) and PO_4^{3-}(0.8 ± 0.521 to 7.0 ± 3.512, respectively. The higher pollutant load that was observed along the downstream confirms the impact of floriculture activity. In addition, the result of physiochemical parameter also compared with WHO, FAO, and US-EPA Water quality guideline and the sources of pollution was also classified. Therefore the result of most water quality parameters were beyond the permissible limits of WHO, FAO and US-EPA water quality guideline values for use as a raw public water supply, irrigation, maintenance of fisheries and aquatic life respectively. So, proper floriculture wastewater management system and integrated pest management system are suggested.

Key words: *Lake Pollution, Floriculture, water quality, effluent, wastewater and contamination*

Introduction

The critical problem in national economies in relation to water is the amount of economic losses due to freshwater pollution which includes: costs to establish further water treatment facilities to use water for different purposes, loss of economically important commercial fish species, degradation of biodiversity in the aquatic environment, decline of productivity due to problems and disease related to water quality, Decline in agricultural production due to increased salinization of water, or inability to use severely polluted water, increased production cost of different industries due to water quality deterioration, cost due to mobility of population caused by degradation of aquatic environment (Berhanu, 2008).

Water quality of any water body can be influenced by Nature, Human activities or both. The natural influences that can affect water qualities could be, the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, by the natural leaching of organic matter and nutrients from soil, by hydrological factors that lead to runoff, and by biological processes within the aquatic environment that can alter the physical and chemical composition of water. As a result, water in the natural environment contains many dissolved substances and non-dissolved particulate matter. Dissolved salts and minerals are necessary components of good quality water as they help maintain the health and vitality of the organisms that rely on this ecosystem service (Gasc *et al.*, 2018).

Drinking water quality guidelines and standards are designed to enable the provision of clean and safe water for human consumption, thereby protecting human health. These are usually based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms. Guidelines for the protection of aquatic life are more difficult to set, largely

because aquatic ecosystems vary enormously in their composition both spatially and temporally, and because ecosystem boundaries rarely coincide with territorial ones. Therefore, there is a movement among the scientific and regulatory research community to identify natural background conditions for chemicals that are not toxic to humans or animals and to use these as guidelines for the protection of aquatic life (Becht, 2007).

Ethiopia, like many other developing countries, is attempting to diversify its export base with a view to gaining new sources of income and foreign exchange; and thus, reducing its exposure to price volatility that typifies international markets. Besides, the country is benefiting from this development through creating employment opportunity for unemployed citizens. Recently, Floriculture is booming in the country but there are a number of challenges that must be resolved to continue the development of the sector with present rapid speed. Among the challenges include environmental impacts of the sector which can create pressure on the sustainability and market acceptability of flower industries (Teklu *et al.*, 2018).

Environmental impact assessment in the industry, the presence or lack of laws and standards in the use of chemical fertilizers and pesticides and the practice of monitoring of the same, if any, the feasibility of tasks done by the floriculture farmers and agencies to minimize the adverse environmental impact of the sector's water use and disposal of waste. Moreover, the extent to which the industry observes the compliance standards required in binding instruments and regulatory schemes will be assessed. In many cultures fresh cut flowers are deeply symbolic. As a gift they embody a universal desire for connection to other people, to the beauty of nature, to God (Redwan-Muhammed, 2016).

Recently, a large-scale horticulture and floriculture greenhouse complex has been established at the Shore of Dembal Lake providing new and badly needed employment opportunities to the local population, which mainly depends on smallholder agriculture while a part receives food aid. On the other hand, this development will further increase the pressure on local water resources as the greenhouses depend on surface water from Dembal Lake for irrigation, while other inputs (nutrients and biocides) may increase the risk of environmental pollution (Hengsdijk and Jansen, 2006).

Dembal Lake is well known for its aquatic bird life and other aquatic animals such as the 11 fish species (of which one is exotic), various species of phytoplankton, zooplankton and other micro flora, there are also terrestrial plants and animals found around the lake constituting its fauna and flora. However, Lake's resources have been misused causing resource degradation and ecosystem disturbance (Jansen *et al.*, 2007).

Horticultural production is increasing in the Rift Valley area where there is an extensive investment in commercial cash crops like cut-flowers, vegetables and fruit both by large commercial and smallholder farmers. A large proportion of these new developments practice conventional production, using agrochemicals to increase yield potential (Teklu *et al.*, 2018).

Initiative of this area include: Flower farms mostly use those hazardous chemicals in the form of fertilizers or pesticides which can be easily washed off from the ground and enter into water bodies. Moreover, excessive usage of inorganic chemicals in the farms which later produce nitrate soon after will get into water bodies which can be washed away from the farms by rain or some other means can cause serious problem like eutrophication and contaminated water body can develop water borne diseases. Because of this there was frequent conflict raised between the community and the flower farms. This Paper was mainly focusing on evaluate the Effects of

2. MATERIAL AND METHODS

2.1 Description of the study area

The study was conducted around Dembal Lake, the Great Rift Valley zone of Ethiopia. It is situated in east showa zone of oromia region at about 160 km from Addis Ababa. Dembal Lake has an open water area of 434 km2, average depth of 4m, and an elevation of 1636 m. s. l. The Batu Watershed falls in between 7°15'N to 8°30'N latitude and 38°E to 39°30'E longitude covering a total area of about 7300 km2. It is composed of two main rivers flowing into the lake, Meki and Katar, and one Lake flowing out of the lake, Bulbula. Floricultural farm industry is situated between Dembal Lake and the main highway with altitude ranges between 1600–1700 meters above sea level (Wondim, 2016).

The geographical/astronomical/ location of Batu town is at 8044'40''N latitude and 38059'9''E longitude at an Altitude of 1925 m. s. l and It is characterized with a humid tropical climate and intense precipitations from June to August. The air temperature varies around the year from a minimum of 06°C to a maximum of 36 °C. The town covers about 10000 hectares of area. There are 1 (one) floricultural farm industry established around the Dembal Lake which is found 1 km away from the town.

2.2. Research Approach

A mixed method that was used by (Jonhson *et al.*, 2011) referring procedures of collecting and analyzing both qualitative and quantitative data in the context of a single day was employed. The qualitative and quantitative data were collected through questionnaire, field-based interview and observation, and analyzed to synthesize the report. A primary quantitative data were generated from a laboratory and supplemented by the information collected through other methods to reach the conclusion.

Figure 1 Location map of study area

2.3. Research Design

Both qualitative and quantitative data were collected through questionnaire, interview, FGD, observation and laboratory analysis. A structured questionnaire was prepared and distributed to local duelers and gather qualitative and quantitative information. The physical observations were conducted using structured checklist. The key informant interview was also conducted. Besides laboratory analysis of selected representative samples collected from the lake were analyzed and information was used to reach conclusion. The samples were collected from purposely selected points including upstream, middle stream, downstream and control pristine lake environment.

2.4. Method of data collection/ Technique of the researches/

The researcher use observation, interview, FGD, questionnaires, and document review was used to conduct the study and this selected for the reason that it enables the study to investigate and assess the available information's about the issue such as sources from various governmental and non-governmental organizations and interviewing the employee in floriculture industry, direct physical site observation and assessing existing situation of the study area and by taking sample from the Dembal Lake.

2.4.1. Observation

Observation is a major data source for this study. It is more appropriate to assess the impacts of fertilizer, pesticides, waste disposal, chemicals usage and intensive use of water resources in the surrounding environment and to obtain a real picture of existing problem. For more accuracy photographs was also expected to take during observation.

2.4.2. Interview

A semi-structured interview guideline was used to obtain data from different officials such as City Administration, Environmental protection office, UHEPs (Urban Health Extension

Professionals), from manager and experts of the flower company.

2.4.3. Questionnaires

Both open and close ended questionnaires were prepared, tested at pilot scale before it was applied for data collections. Then, it was revised and translated into Afan Oromo and Amharic language. Finally, it was employed for data collection.

2.4.4. Secondary data

A secondary data was collected from different sources such as reports, published and unpublished materials from online, operational reports from administrative office, and websites.

2.5. Sample frame

It is a list of all the sampling units from which sample is drawn and for this study the sample frame was focused on 5 (five) floriculture farms which founds in one compound that established around the Dembal Lake, UHEPs (urban health extension professionals), town administration, and Environmental Protection office.

2.6. Sampling unit

About 5 (five) floriculture farms that were constructed around the Dembal lake, UHEPs (urban health extension professionals), town administration, and Environmental Protection office were taken as sampling units. Sample respondents for the questionnaire survey were selected from these sampling units. Also, four laboratory water sampling units where the sample was collected from upstream, middle, lower and pristine sampling lake sites were identified.

2.7. Sampling methods and techniques

2.7.1. Sampling techniques

Both probability and none probability sampling techniques were adopted. Simple random sampling technique was used to identify questionnaire respondents whereas; a purposive sampling technique was applied to select the laboratory water sampling locations.

The sampling sites were located by using GPS (Global Positioning System) and accurately marked on the map. Sample collection was done by direct immersion of the polyethylene vessels in to the lake. A total of nine (9) samples were collected for one month and once in a week (two composite samples per each site) starting from March to April.

2.6. Laboratory water Sampling and preservation

In this sampling method, a random starting point was selected and samples were taken at monthly intervals. The samples for all parameters were collected at the same day from the surface and 0.5 meters from the bottom of the lake to achieve consistency in sampling and evaluate depth variation.

Water samples for chemical analyses were collected in a clean, white 2 liter polythene container. Before collection of sample, the container was thoroughly rinsed with the water to be sampled to avoid errors due to contamination of the containers by foreign contaminants. The sample was labeled properly before it was transported to the laboratory using a permanent marker both on the container and on the stopper. For bacteriological examination, the water was collected using a pre sterilized 500ml glass bottle .The sample collection procedures follows standard procedures (Verlag, 2002).

The samples was transported to the laboratory using an ice filled Ice box, and reached the laboratory, and analyzed within 24 hours from the time of collection. Sampling time was arranged to include all time and condition of the day at a regular interval from 8:30 A.M to 6:30 P.M. On every sampling date, attempt was made to collect the most representative samples from the same area in triplicate keeping also the same collection time in all round campaign of sample collection.

The samples were taken from the upper parts of the catchment, the middle one where many point sources are found, and from lower stream parts. From this water samples the study was try to analyze PH, TDS, TSS, electrical conductivity (EC), Nitrate (NO_3-), reactive phosphate (PO_4^{3-}), Biological oxygen demand (BOD), and chemical oxygen demand (COD), parameters.

3. Result

3.1. Assessment of pollutant sources at the Shore of Dembal Lake

A reconnaissance survey was conducted around the lake area to identify the sources of effluents. There are five farms inside the Flower Company; some of the farms already put in to practice waste water management techniques. However, most of the farms directly discharge the effluent in to the Lake without any waste water treatment procedures. Each farm has a pipe and a waterway from the greenhouse to the Lake, which is used to pump the water from the lake and to discharge the effluent back. Based on the site survey, five points was chosen along the greenhouses to assess the concentration of physicochemical, nutrients, and oxygen demanding parameters.

In order to see the impact of the farm effluent on the water quality of the Lake, the first site (SS_1) was chosen at the upstream area 1.5km away from the farm which is used as a control, (SS_2) was located at the point of disposal of the first two farms which have been applying waste water management techniques to reduce the impact on the lake. (SS_3) was chosen at the point of disposal of flower farms which doesn't apply waste water management techniques and (SS_4) was chosen at the point of disposal greenhouses. The last site (SS_5) was chosen at the downstream area a little bit far from the greenhouses which was used to observe the cumulative effect on the Dembal Lake.

3.2 Analytical Methods

Water samples was collected and analyzed for PH, electrical conductivity (EC), Turbidity, Total suspended solids (TSS), and Total dissolved solids (TDS), Nitrate (No_3^-), orthophosphate (PO_4^{3-}), Dissolved Oxygen (DO), Biological oxygen demand (BOD), chemical oxygen demand (COD), and parameters at EPA Laboratory Center.

The turbidity of the water was determined photo electrically using photometer and digital turbidity meter. The meter was calibrated using standard samples, once the meter is calibrated to correctly read these standards; the turbidity of the water sample was taken. PH was measured using JENWAY model 3510 PH meter; TDS and EC was measured using JENWAY model 470 conductivity meter. Vacuum pamper will be used to measure TSS. Nitrate and orthophosphate was analyzed by using HACH spectrophotometer Model DR/2400 in accordance with the HACH procedural manual (Tamiru and Leta, 2017).

Dissolved oxygen was measured with DO meter (Model GENWAY 9150), Chemical oxygen demand was determined using a HACH DR/2016 photometer (HACH, USA) and BOD5 was measured following instruction ('Addis Ababa University School of Graduate Studies Environmental Science Program Environmental Impacts of Floriculture Industries on Lake Ziway : With Particular Studies Environmental Science Program Environmental Impacts of Floriculture Industries on Lake', 2009)

3.3 Materials

The methods of analysis for water pH is potensio metric, PH was measured using JENWAY model 3510 pH meter; EC were measured using JENWAY model470 conductivity meter. The EC is also analyzed by potensio metric method. Chemical oxygen demand was determined by using a HACH DR/2016 photometer (HACH, the COD is analyzed by open replax method, USA), PO_4^{3-} is analyzed by coloro metric method which is used the instrument called Spectro photometer and BOD5 was measured following instruction (Tilahun Advisor, 2013).

3.4 Data analysis / statistical Analysis

The data collected for this study was analyzed using SAS (Statistical Analysis System, version 9) for variation in physicochemical, oxygen demanding and nutrient concentrations between the control and impaired sites and also among different Sampling sites. The results of physicochemical parameters were also compared with water quality standards to check whether the lake water is within the acceptable range for irrigation and domestic water use.4.

4. RESULTS AND DISCUSSION

Measurements of the physico-chemical parameters at sample sites (water sample) were taken in the morning while the biological samples were being collected (7:05-9:20 AM). Average air temperatures ranged from 22.9°C to 24.2°C between sites. The small differences were attributed to variable sampling times (between 7 a.m. and 9 a.m.) Relative humidity at sites was also very consistent.

The physico-chemical parameters of the composite Sher Ethiopia floriculture effluent and Dembal Lake water was analyzed and compared using standardized (FAO, WHO, and Ethiopia-EPA) guidelines for the maintenance of fisheries and aquatic life use; to check if the result is within the acceptable range and also to check the compliance level of floricultural to be released to the Dembal lake.

Table 1 Mean values of physicochemical parameters, Dissolved Oxygen and Nutrients (Mean ± SE, n=4) at 5 study sites.

Parameters	Sampling site				
	SS_1 (Control)	SS_2	SS_3	SS_4	SS_5
Turbidity (NTU)	18.3± 6.5	30.3±17.5	33.5 ± 29.5	37.5 ± 21.5	35.25±20.5
TSS (mg/L)	0.043± 0.05	0.056±0.16	0.063±0.11	0.225±0.15	0.35±0.01
TDS (mg/L)	350.1 ±9.8	426.3 ±83.5	533.7±175.5	627.1 ±178.6	570.0 ± 175.5
PH	8.7 ±0.22	8.8 ± 0.42	8.8 ±0.25	8.9 ± 0.5	9.3 ± 0.31
EC (ds/m)	0.657 ± 0.0455	0.8 ±0.91	0.96 ± 0.15	1.52 ± 0.43	2.24 ± 0.3
COD	96.4 ± 3.5	111.7 ± 6.451	117.5 ± 5.21	121.0± 10.4	127.5 ± 6.34
BOD	17.3 ± 1.16	19.4 ± 1.142	22.7 ± 3.12	25.6 ± 7.11	23.34 ± 7.52
NO_3^- (mg/L)	2.88 ± 2.35	17.9 ± 17.12	34.9 ± 4.36	29.45 ± 20.31	52.5 ± 19.35
PO_4^{3-} (mg/L)	0.8 ± 0.521	2.30 ± 0.576	5.8 ± 1.51	7.63 ± 3.325	7.0 ± 3.512

TSS= Total suspended solids TDS= Total dissolved solids EC = Electrical Conductivity

As the result of physio-chemical parameter that illustrated in the Table (1) showed that the quality of the lake water at the pristine ecosystem was no human intervention has recorded. Also the site was relatively within the acceptable range for the variety of uses of the lake water. However, the mean value of the other sampling sites of the lake has been increased along the downstream.

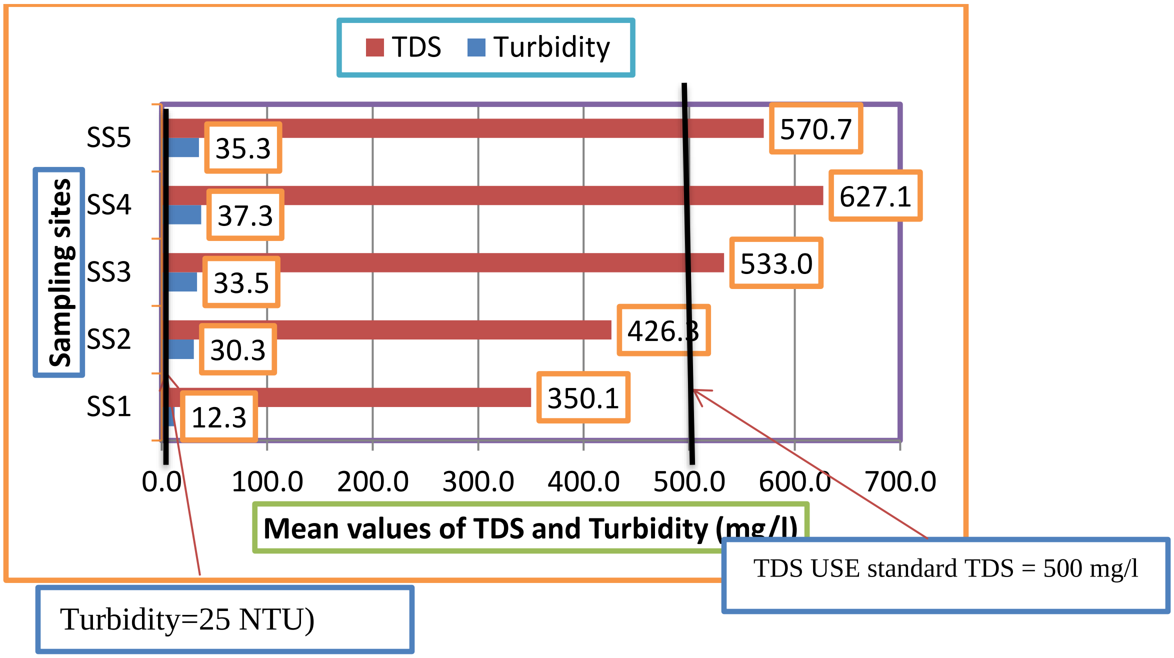

Figure 1 Relations b/n TDS &Turbidity (Mean ± SE, n= 4) at 5 study sites of Dembal Lake

Turbidity is the amount of particulate matter that is suspended in water.

As showed in Figure (1) the Mean values of Turbidity revealed that there were significant differences between the control and the other sampling sites ($p<0.05$). The Turbidity value of the lake water has been increased along downstream. At the pristine lake ecosystem there were no human intervention has recoded were (12.3 ± 6.5) mS/cm. However, the Turbidity of other sampling sites that showed in Figure (1) was relatively increased along downstream respectively.

This is due to the excavation of the soil and high numbers of sedimentation at the downstream and it caused by the suspended materials that scattered light passing through the water.

In addition, FAO, WHO, and US-EPA guideline values in (Table 2) for agricultural irrigation, maintenance of fisheries and aquatic life and for use as a raw public water supply or domestic use were also compared with the results to check whether the lake water is within acceptable range for the required use.

Therefore, the quality of the lake water in the upstream area (Control site) was relatively within the acceptable range for the variety of uses of the lake water. But, the level of lake Turbidity concentrations at the following sampling sites (SS_2, SS_3, SS_4, and SS_5) where gradually increased due to the flower farms around these sites discharge the effluent directly in to the lake without threating the effluent water.

Similar report was done by (Berhanu, 2008) showed that the Turbidity of the lake increased from upstream to downstream respectively. In addition (Tamiru and Leta, 2017) showed that the Turbidities of less than 10 NTU represent very clear waters; 50 NTU is cloudy; and 100-500 or greater is very cloudy to muddy. Some fish species may become stressed at prolonged exposure of 25 NTU or greater.

As showed in figure (4.1) the mean values of Total Dissolved Solid were significance differences between the Control and other sample sites ($p<0.05$). TDS mean values of the lake water were relatively greater at SS_3 (533.0), SS_4 (570.7) and SS_5 (627.1) mg/L respectively.

This could be due to the farms around these sites discharged untreated effluents in to the lake which led to a negative effect on the lakes water quality.

TDS value between 450-2000 mg/L has slight to moderate irrigation problem and the mean values of TDS at Dembal Lake were between these ranges. Except the control sites, mean values of TDS were above the water quality guidelines for fisheries and aquatic life; it also exceeded WHO standards.

The same result was also reported by (Gudeta, 2012) who studied on the ecological impacts of floriculture industries effluent using physico-chemical parameters along Wedecha Lake in Debrezeit.

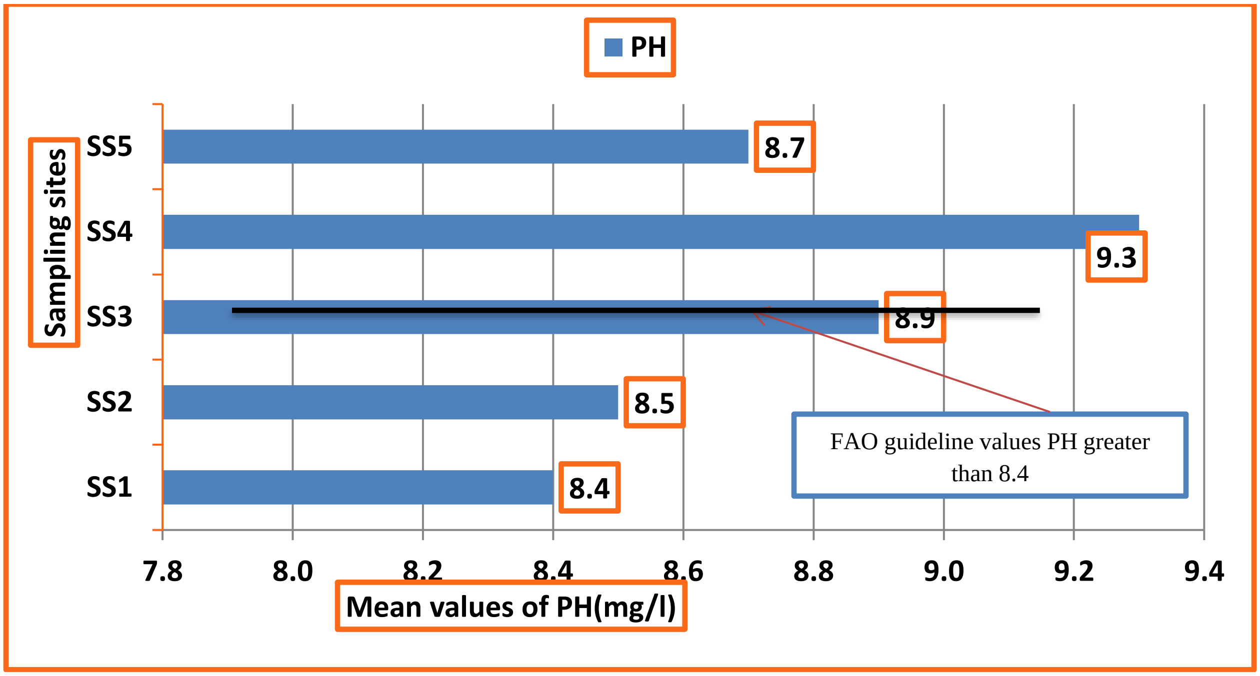

Figure 2. Mean value of pH (Mean ± SE, n=4) at 5 study sites of Dembal Lake

The PH of the water is important because it affects the solubility and availability of nutrients and how they can be utilized by aquatic organisms. Dembal Lake is slightly alkaline in nature due to the geology of the rocks in the area.

As the result showed in figure (2) the Mean values of the lake pH revealed that there was significant difference between the control and other sampling sites ($p<0.05$). The mean pH value of the lake in figure (4.2) showed that there were gradually increased from 8.4 ± 0.22 (Control site) to 9.3 ± 0.31 (SS4) and decrease again at the downstream. These variations in PH could be explained by addition of PH reducing agents to increase availability of micronutrients.

The PH of Dembal Lake is around 8.8 because of the geology and rocks of the surrounding catchments However, the PH of most natural waters are in the range of 6.0-8.4.

The PH of the Lake slightly exceeded FAO and WHO water quality guidelines for irrigation and use as raw public water supply in both the control and other sample sites. This could show that the lake water is becoming less suitable for irrigation and domestic use.

The work of (Malefia Tadele, 2009) and (Gasc *et al.*, 2018) who studied on the environmental impacts of floriculture industries on Lake Ziway: with particular reference to water quality also supported this idea;

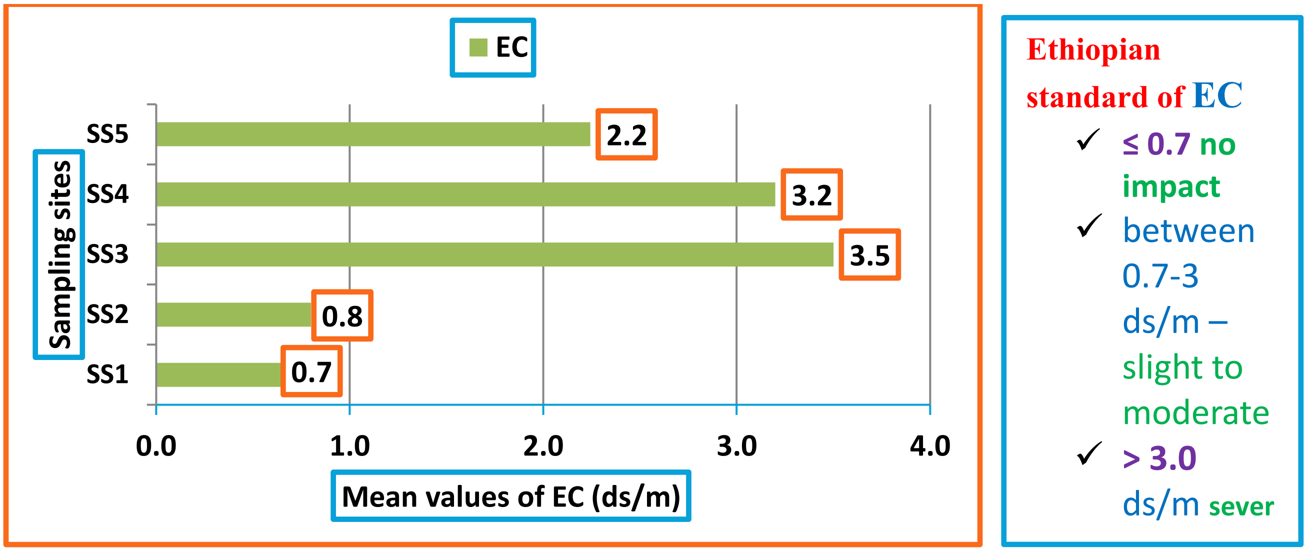

Figure 3. Mean value of EC (Mean ± SE, n=4) at 5 study sites of Dembal Lake

As showed in Figure (3) The mean values of the lake Electrical conductivity showed significance differences between the Control and other sampling sites ($p<0.05$). The electrical conductivity of the lake was increasing from upstream, middle stream and downstream respectively. This could be due to the farms around these sites discharged untreated effluents in to the lake which led to a negative effect on the lakes water quality. EC estimates the amount of total dissolved salts or the total amount of dissolved ions in the water. High electrical conductivity indicates high dissolved solids concentration; dissolved solids can affect the suitability of water for domestic, industrial and agricultural uses.

According to FAO water quality guidelines, electrical conductivity values less than 0.7 ds/m has no potential irrigation problem. However, the values between 0.7-3 ds/m could create slight to moderate problems on irrigated lands.

The mean values of Electrical conductivity of the lake water measured at (SS_3, SS_4 and SS_5) showed the values greater than 0.7ds/cm, which might reveal the environmental impact of the farm effluent on the lake water. The work of (Gasc *et al.*, 2018) also agreed with these ideas; the farms around Lake Ziway discharged untreated effluents into the lake which led to a negative effect on the lakes water quality. Similar result was also obtained by (Malefia Tadele, 2009) the higher EC values were found for sampling points near the floriculture area of Lake Ziway.

Table 2 Guideline values for some selected parameters

Fisheries and Aquatic life			Drinking Water			
Variable	Unit	EU	Ethiopia	WHO	EU	USA
pH	-	6-9	6-9	6.5-9.5	6.5-8.5	6.5-8.5
EC	Ms/cm	-	100	-	-	-
TDS	Mg/L	-	-	50	-	50
TSS	Mg/L	25	≤ 25	-	-	-
NO_3^-	Mg/L	-	-	-	5	-
PO_4^{3-}	Mg/L	-	≤ 5	-	-	-
BOD	Mg/L	-	≤ 150	-	-	-
COD	Mg/L	-	≥ 4	-	-	-

Sources: Chapman, 1996; EPA/UNIDO, 2003; WHO, 2004 P = Provisional standard

Table 3 Guidelines for Interpretation

Parameters	Units	Degree of restriction on use		
		None	Slight to moderate	Sever
EC	Ds/m	≤ 0.7	0.7-3.0	> 3.0
TDS	Mg/L	< 450	450-2000	> 2000
NO_3^-	Mg/L	< 5	5-30	> 30

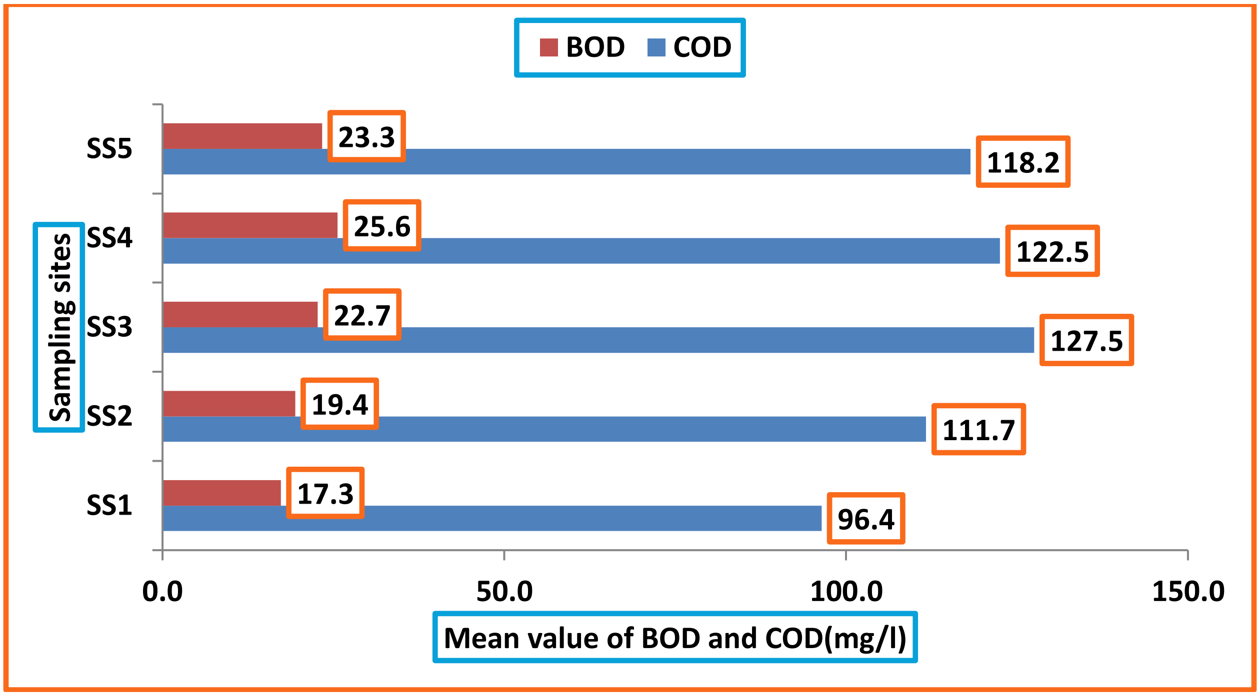

Figure 4: Relations b/n BOD & COD (Mean ± SE, n=4) at 5 study sites in Dembal Lake

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria was consume while decomposing organic matter under aerobic conditions. Oxygen is important for life continuity in the water if the amount of oxygen is become less and less, the organism live in the water is exposed to severe condition and finally for extinction. However, Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material in to carbon dioxide and water.

As showed in Figure (4) the mean values of Biological oxygen demand of the lake were significant difference between sampling sites ($P<0.05$). The mean BOD values of the lake at study sites were ranged between 17.3 ± 1.16 (control) to 23.34 ± 7.52 (SS_5) downstream respectively, this could be due to excessive concentration of nutrients at the downstream area which increased the demand for dissolved oxygen by bacteria to decompose these organic materials.

BOD values in both the control and other sampling sites found to be above the guideline values (5 mg/L) of Ethiopia for fisheries and aquatic life.

As showed in Figure (4) the mean values of COD of the lake were significant difference between sampling sites ($P<0.05$). Thus the COD of the lake increase from 96.4 ± 3.5 (control) to 127.5 ± 6.34 (SS_3) and decrease again at the downstream respectively, This could be due to the farms around these sites discharged high level of organic and inorganic wastes in to the lake which led to a negative effect on the lakes water quality.

High levels of COD and BOD values in the study area could be due to excessive organic and inorganic wastes in the farm effluent.

Similar result was also obtained by (Gordon, McMahon and Finlayson, 1992) and (Redwan-Muhammed, 2016) that High levels of COD and BOD values in the study area could be due to excessive organic and inorganic wastes in the farm effluents.

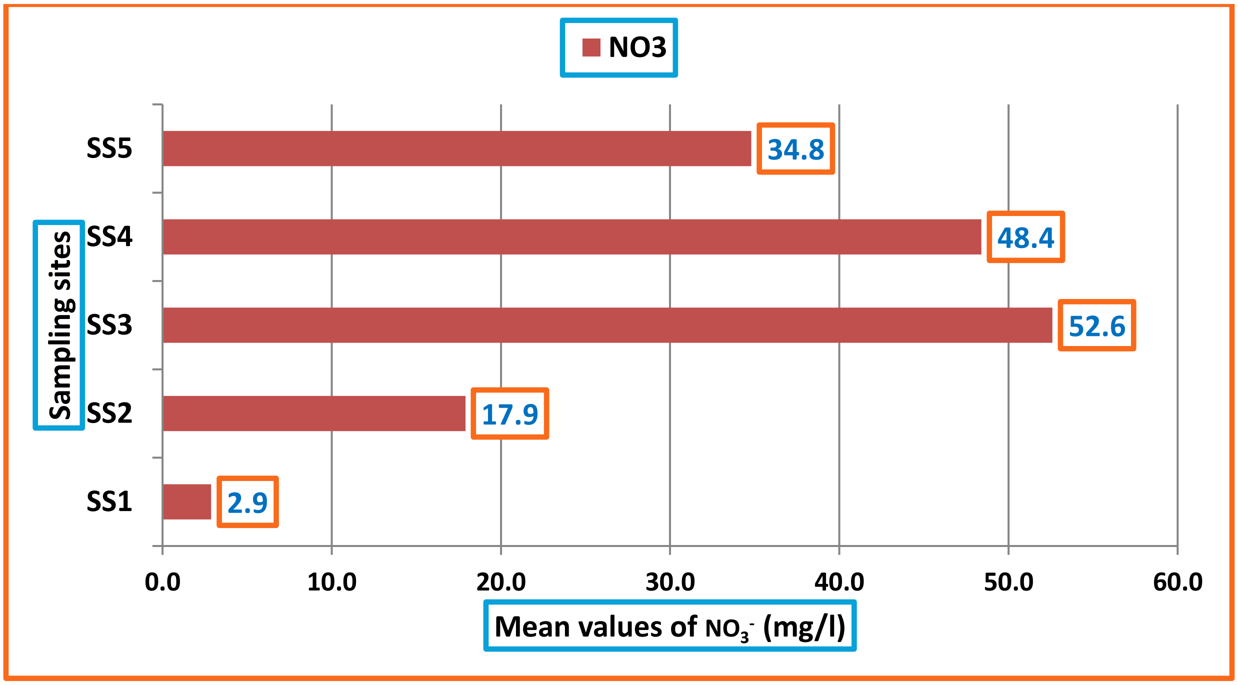

Figure 5: Mean values of $\mathbf{NO_3^-}$ (Mean ± SE, n=4) at 5 study sites in Dembal Lake

As showed in Figure (5) Mean values of Nitrate of the lake revealed significant difference between the control and other sampling sites ($p<0.05$). The mean values of Nitrate concentrations in the lake were very high at SS_3 (52.6 ± 4.36) and SS_4 (48.4 ± 19.35) when it was compared with the control (2.88 ± 2.35); this could be explained due to the use of excessive fertilizers by the farms located at the downstream area. Increased nitrate levels near SS_3 and SS_4 caused excessive algal growth, which might be the reason for reduced levels of oxygen.

Based on FAO guidelines, NO_3^- values between 5-30 mg/L have slight to moderate problems for irrigation; values >30 sever. The ambient standard to protect aquatic ecosystems is 10 mg/L (Government of Ethiopia, 2019).

An increase in nitrate may be followed by an increase in phosphates. As phosphates increase and the growth of aquatic plants is encouraged, algal blooms can occur with the increase in algae growth and decomposition, the dissolved oxygen levels will decrease. Nitrogen is also a concern in drinking water because an increased level of nitrate has been linked with blue-baby syndrome in infants.

The report of (Abayneh Tilahun, 2013)also agreed with this ideas, the concentration of nitrate at Wedecha Lake was 16.6 mg/L; high concentration of nitrate in the water body is due to the fertilizer that the flower farms used and discharged.

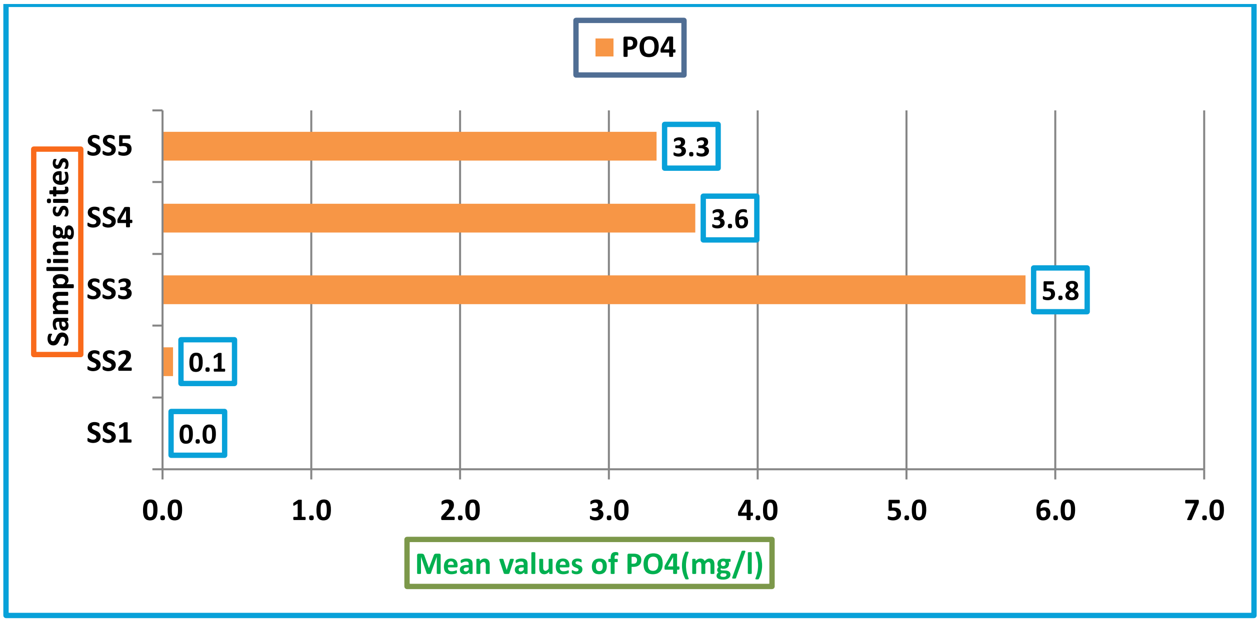

Figure 4.6 Mean values of $\mathbf{PO_4^{3-}}$ (Mean ± SE, n=4) at 5 study sites in Dembal Lake

As showed in figure (4.6) the mean values of the Phosphate of the lake were significant difference between the control and other sampling sites ($p<0.05$). Thus, the mean values of the Phosphate of the lake were gradually increased from upstream to downstream respectively. The concentrations were very high at SS_3 (5.8 ± 3.325) and SS_4 (3.6 ± 3.512) when it was compared with the control (0.0035 ± 0.521) that showed in figure (4.6). The mean values of PO_4^{3-} concentration in both control and other sampling sites were beyond FEPA provisional standards (PO_4^{3-} = 0.005 mg/L). The reason for increased levels of Phosphate in the lake could be due to the use of excessive fertilizers residues by the flower farms located at the lake shore area that enter in to the lake.

Also the mean values of the PO_4^{3-} concentrations of the lake at the both sampling sites were beyond the FAO and WHO guideline values for maintenance of fisheries, aquatic life and domestic use. High levels of PO_4^{3-} in the lake water promoted excessive growth of algae in the lake near the outlet of the farm; which led to reduction in dissolved oxygen level. This might be the cause for the decline of fish catch near the outlet of the flower farm in the Dembal Lake.

The work of (Joosten, 2007) stated that high phosphate (5.6 mg/L) and nitrate (33 mg/L) levels in Lake Naivasha as a result of runoff from floriculture farms located at the shore of the Lake region might be the cause for increased phytoplankton biomass in the Lake. In addition similar result was also obtained by (Abayneh Tilahun, 2013)that excessive amounts of phosphorous in a system can lead to an abundant supply of vegetation and excessive growth of algae, and consequently low dissolved oxygen.

4. CONCLUSION

Economically the floriculture industry is playing a vital role and contributes a lot to country's GDP, but in other side the industry has its own environmental and social health impact, due to the input the industries utilize. The fertilizer, chemicals, intensive use of surface water, and the conversion of wetlands and farm lands for flower industries, the bad smell from chemicals, the waste disposal to water body and some health problems. This all are negative impacts of the industry which is analyzed by this research paper.

Floriculture industries located at the shore of Dembal Lake have been creating much needed employment opportunities to the local people which mainly depend on smallholder agriculture; it has been also helping the country to generate foreign exchange. However, these industries located near Dembal Lake are using a broad range of fertilizers and pesticides; the farm effluent is directly discharged in to the nearby lake which led to deterioration of the lake water quality and aquatic life.

In this study, the results of Physicochemical, Oxygen demanding and nutrients parameters analyzed at the sampling sites were compared with samples taken at the upstream area (control) which showed significant difference in physicochemical, nutrients and oxygen demanding parameters. The levels of these parameters were high at the downstream especially in sampling sites where the effluent was directly discharged to the lake water and the areas were the waste water management was not put in to practice.

Besides, the results were compared with water quality guidelines to check if the water quality of the lake is within the acceptable range. Based on the guideline values, the potential irrigation problem of the lake water near the farm were slight to moderate and it is also becoming less suitable for the maintenance of fisheries and aquatic life.

Although the water quality of Dembal Lake is still acceptable for irrigation under the current condition, the high levels of fertilizer residues in the farm effluent is promoting growth of algae and aquatic vegetation beyond what is naturally sustainable. In addition, the Lake water around the farm is becoming less suitable for sanitation purposes. In general because of the activities of the flower farm on the Lake, the water quality may seriously deteriorate and fish catches was decline near the shore of the lake. Unless immediate measures are taken, the lake water will be heavily polluted and become unfit for the variety of purposes being used before.

Conflicts of interests

There is no conflict of interests

Author contribution

All authors have contributed in study design, data collection, analysis and report writing.

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