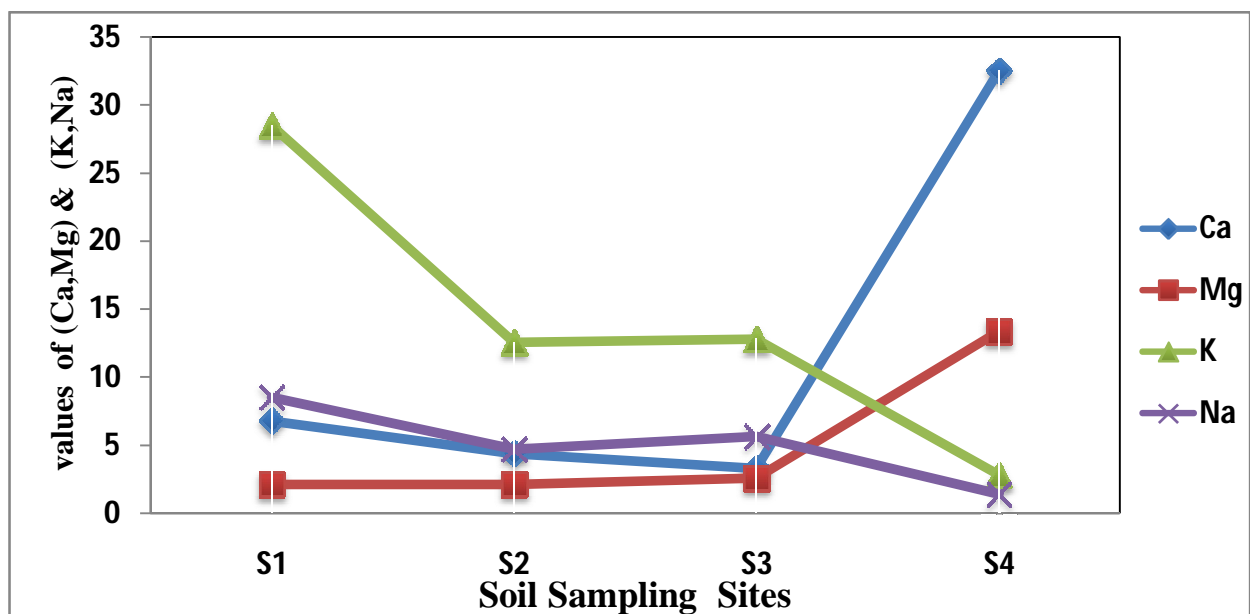


ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES



ASSESSMENT OF SOIL AND WATER CONTAMINATION DUE TO LARGE SCALE FLORICULTURE FARMING AROUND LAKE ZIWAY



M.Sc. Thesis in Environmental Geology

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Msc thesis submitted to the Addis Ababa University School of graduate Studies in partial fulfillment of the requirements for the degree of Master of Science in Environmental Geology

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This is submitted to the school of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in environmental geology.

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ABSTRACT

The main environmental risk of the floricultural production is associated with the extensive use of pesticides and herbicides and the fate of their residues in the soil and water. An intensive use of agrochemicals is taking place in a context of weak and un-harmonized regulations. Nevertheless, the potential of the residues from the horticulture and floriculture systems on surface water resources, particularly Lake Ziway, the freshest water lake; on the top of that, floriculture industries located at the shore discharging untreated effluent directly in to the lake;

Both the small scale and large scale floriculture and horticulture farms lack adequately trained personnel for appropriate pesticides management and appropriate organization setup. Moreover, local communities and producers seem to remain largely unaware of the advantages of sustainable management of natural resources leads to environmental degradation such as land, water and soil quality degradations. Therefore, this study was proposed with the objective of assessing the impact of floriculture industries on the soil water quality of the area.

The necessary data are collected by direct physical site observation and assessing existing situation of the study area and by taking sample from the soil and lake adjacent to the farms. a total of eight samples were collected, and each has four sampling points; four sampling points, Eight parameters were analyzed for the water samples (pH, electrical conductivity (EC), Nitrate (No₃-N), reactive phosphate (PO₄), Biological oxygen demand (BOD), and chemical oxygen demand (COD), Sulfate (SO₄), Total ammonia (T-NH₃).in addition to this, the soil samples have been analyzed with five parameters ,(pH, CEC, EC, Phosphorus (P) and total Nitrogen (TN)) for the soil SS4 were chosen as a control sample which is relatively few meters far from the farm effluent.

The results showed higher levels of TDS (292 to 1116), EC (507 to 1874), PH (7.97to 7.82), COD (291.2 to348.4) BOD (500 to 900) NO₃-(1.09to 12.45) andPO₄-(0.09 to 0.57) at the impaired sites where the effluent was directly discharged without treatment the concentrations also showed a very high increment when compared with the previous study results. And the same is true for the soils, EC(307to8780),PH,(6.48to10.53)P(5.02to29),OC,(0.41 to7.17) also has a great difference when compared with the control sites. . In addition to this, both the soil and water results were also compared with quality guidelines and standards, EPA, WHO, FAO to check if the concentrations of these parameters were within the permissible limits. The identified environmental impacts are water resource utilization, water and soil quality degradation, and land cover changes

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Acronyms

BOD	Biological Oxygen Demand
CEAA	Canadian Environment Assessment Act
CEC	Cation Exchange Capacity
COD	Chemical Oxygen Demand
EC	Electrical Conductivity
EHPEA	Ethiopian Horticultural Producers and Exporters Association
EIA	Environmental Impact Assessment
EPA	Federal Environmental Protection Authority
EPE	Environmental Policy of Ethiopia
EU	European Union
FAO	Food and Agricultural organization of the United Nations
m.a.s.l	Meters Above Sea Level
MPS	Milieu Program Sierteelt
Mg/l	Milligram per liter
MoRAD	Ministry of Agriculture and Rural Development
PH	Power of Hydrogen
SEA	Strategic Environmental Assessment
µS/cm	micro Siemens per centimeter
UNEP	United Nation's Environmental Program
USEPA	United States Environmental Protection Authority
WHO	World Health Organization

1. INTRODUCTION

1.1. Background of the study

The Central Ethiopian Rift valley is characterized by a chain of lakes and wetlands with unique hydrological and ecological characteristics. Increasing population pressure and economic developments put increasing claim on the precious fresh water resources. Until recently, water from the lakes mainly supported agriculture and commercial fishery, domestic use, industrial soda extraction and recreation, while the lakes and surrounding wetlands supported a wide variety of endemic birds and wild animals. Recently, large-scale foreign and national horticulture and floriculture enterprises have been settling down in the area thanks to suitable climate conditions (high radiation, appropriate day-length, cool night and high daytime temperature, favorable humidity), availability of land and labor at low costs, favorable investment conditions (e.g. tax exemption), shorter distance to the European market than competitors (Kenya and Ecuador) while logistics and handling facilities are rapidly improving.

These enterprises also claim part of the limited water resources for irrigation and processing purposes. In addition, it is expected that the agricultural development will attract people from other parts in Ethiopia, resulting in new settlements and associated domestic water demand. In addition to water quantity aspects, also water quality aspects will be increasingly at stake as a consequence of agricultural developments and settlements in the area, and the input use (pesticides and fertilizer nutrients) associated with the production of high value agricultural crops like vegetables and cut-flowers (HuibHengsdijk & Herco Jansen2006)

Thus, the large scale horticulture and floriculture greenhouse complexes has been established at the shore of lake Ziway has involved progressively more intensive use of land resources leading to environmental degradation especially through its impacts on soil and water resources of the area and with this greater control and pressure on local habitats leading to environmental change. With the expansion of the floriculture industry, there is a growing concern as to its adverse effect on the national environment. Environmental implication of

floriculture involved the intensive use of water as well as soil, the water and air pollution because of its intensive and toxic chemical usage and waste disposal system of the industries. There are around 120 chemicals that enter the country for the floriculture industry which are found on the negative pesticide list of world health organization, while environmentalists have characterized some of these chemicals as having carcinogenic potential, Such hazardous chemicals are used in the flower farming sector in Ethiopia The need to use waters of the Ethiopian Rift- valley Lakes and their inflows for agricultural, domestic and industrial purposes is increasing; but there seems to be little knowledge as to whether these water bodies are chemically suitable for the purpose of their intended uses. Utilization of the water bodies without information on their chemical composition could be both a health threat and cause degradation of the environment (ZinabuGebre-Mariam, 2003).

Another most visible impact is the depletion of the soil through the intensive usage of fertilizers and chemical as well as during the waste disposal of cut flowers. The different types and amount of chemicals exposes the soil to loss its natural fertility. They have different character and reacted differently when they apply to the soil and change its texture, acidic value and fertility. Researcher from Colombia stated the treats that “Flower farmers in Colombia don’t realize that the intensive use of the soil, the water and the intensive and excessive use of chemicals is going to convert the Savannah of Bogota into a sterile land,” (USEPA, 1996).

According to Albert “Naturally, some amount of water seeps into the ground from irrigate on ditches and canals. In what is called water logging, this seepage can cause the subsoil water table to rise to the root zone of crops, killing them.

The problem can be compounded by salinization, which occurs when water logging brings harmful salts to the surface. Salinization occurs because salt is left behind as irrigation water evaporates, or from leaking of salt and minerals from the soil due to water use for agriculture.

1.2. Description of the study area

The study was conducted around Lake Ziway, the Great Rift Valley zone of Ethiopia. Its situated in east showa zone of oromia region at about 160km from Addis Ababa. Lake Ziway

has an open water area of 434 km², average depth of 4 m, and an elevation of 1636 m.a.s.l. The Ziway 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 river flowing out of the lake, Bulbula. Floriculture industries are situated between Lake Ziway and the main highway with altitude ranges between 1600–1700 meters above sea level (MoWR, 2006).

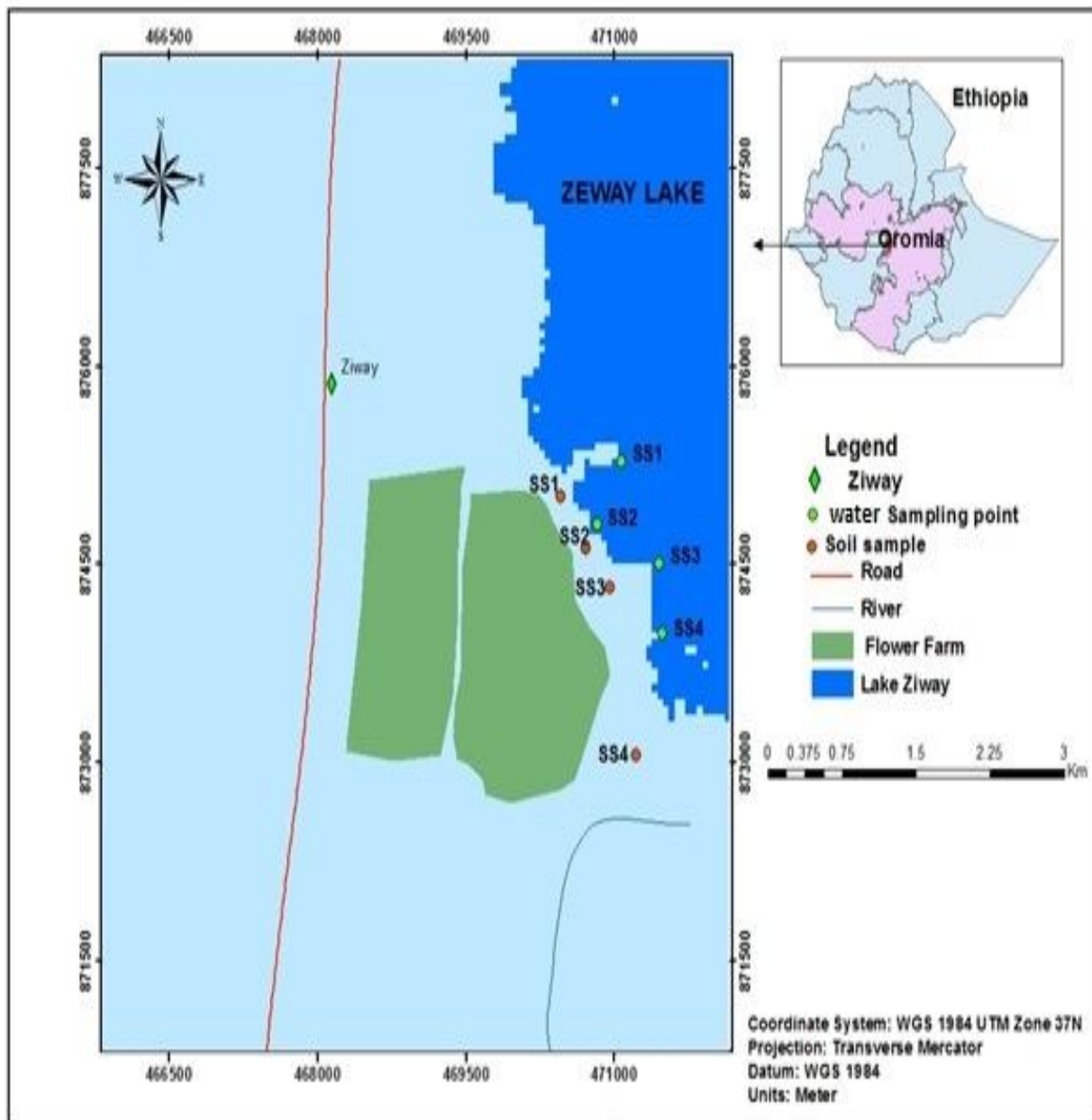


Figure 1-1: location map of the study area

a) Topography

The dominant landform of Ziway plain, which includes Lake Ziway, is flat lacustrine terrace with Andi-Eutric FluvisolsSodic phase, gently undulating terrace with mollic and Eutric Fluvisols and nearly level lacustrine plain with Andi-MollicFluvisols. The altitude of the area varies from 1,650 to 1,850 m.a.s.l. The Rift floor slopes from north to south into central trough, which contains the lakes Ziway,Shalla and Abijata(IBC, 2005).

b) Soils

The areas around Lake Ziway are composed of volcanic rocks, with alkaline lavas, ashes and ignimbrites, mainly of Tertiary and younger age, unwedded pumicious, pyroclastics some coarse beds of lacustrine sediments and alluvial deposits. The sediments covering the volcanic rocks in the area are, generally mixed deposits of sandstone, limestone and silts, with frequent occurrences of evaporite minerals (BGS 2001).

In Ziway, area gentle levees are formed of sandy clay loams. Soils in the eastern and western swampy margins of the Lake are coarse textured with organic loam topsoil over pumic sand. Silty clays have developed on fine textured alluvium along the deltas of rivers Meki and Katar. Alkaline sub soils occur in all areas except the mid-Meki valley. The mid-Meki valley is dominated by heavy-textured soils, which are neutral in reaction (Makin *et al.*, 1974).The terraces of the Lake to the east of Bulbula River and seasonally flooded grasslands bordering the Lake comprise coarse-textured soils on pumice Soils affected by both high salinity and alkalinity occur fairly extensively along the north eastern, northwestern and southeastern shores of the Lake and to the north-west of Adamitulu.

c) Hydrology

Precipitation in the basin, as in the tropics, is very high although there is a time-to-time variation in distribution. There is also high groundwater recharge directly from precipitation. This recharge is therefore an important element in the hydrological cycle. However, due to the layering controls and limited groundwater storage capacity of the volcanic ash, retention of groundwater is only for short period perhaps for a few years. In addition to precipitation, there is indirect groundwater recharge from rivers flowing across the valley floor. These

rivers, which receive flow from the groundwater systems, normally terminate in lakes and rivers (IBC, 2005).

d) Climate

The climate of the area around Lake Ziway has arid and of semi-arid characteristics for most of the year and monthly average rainfall never exceeds evaporation. The mean annual rainfall is 760mm (MoWR 2006). The mean daily temperature at Ziway is 19.3°C. The highest temperatures occur between March and June prior to the start of the main rains, though seasonal variation in daily temperature is relatively slight. The mean annual temperature of the area is within the range of 16-25°C (MoWR2006)

There was a climatic change over the last three decades due to erratic rain and temperature variation in the rift valley ecosystem. The East-South monsoon has an influence on the Rift Valley Lakes. Ziway-Abijata-Langano climatic complex covers an area of over 10,700 km²

Table 1-1: Altitude, area, dimension of the lake and weather summary

Altitude Temp. m.a.s.l	Area Km²	Width km	Length km	RF (mm/yr)	Temp		
					max	mean	min
1650	337	20	25	600-800	28	20	13

Source: Meteorological Data Collected at Ziway Agricultural Research Center

e) Vegetation

There is no closed woodland found in the plain area. Dense woodland and trees around the lake were used to support variety of wildlife. Now, however, they are degraded due to their conversion into different land uses. The areas around the Lake have now been left with only patches of remnants wood and bush lands. According to ZerihunWoldu and MesfinTadesse (1990), the dominant tree species are tortilis, A. seyal, A. snegal, A. etbaica, A.albida, Balanite saegyptica and Dichrostachycinerea. In addition, other woody species like Oleaeuropea sub sp.cuspidata and Acokantherashimperi grow in the escarpments of the hills

bordering the lake, whereas species like *Commiphora shimperi*, *Rhus natalensis* and *Cordia monoica* characterize recovering and protected sites in lower altitudes.

f) Sunshine Hours

The lowest sunshine hours are recorded during the rainy season while the highest values are generally observed in November through February (MoWR 2006).

g) Wind

Strong and persistent daytime winds are significant feature of the Lake Ziway area. During the afternoon in the dry season, the prevailing northeasterly winds are reinforced to the west and south of the lake by local on-shore airflow (MoWR 2006).

h) Population

Before the dwellers on the islands and land surrounding the Lake Ziway were Gurages. However, today the inhabitants of the western shore of Lake Ziway are Oromos (Abdurhman 2002 & James 1977). Orthodox Christians and Muslims form the largest proportion of the religious groups in the area; Catholics and Protestants form minority group (Abdurhman 2002.)

1.3. Statement of the Problem

The intensive use of agro-chemicals used by floriculture industries located at the shore of Lake Ziway has an impact on the soil and water qualities of the area leading to the environmental degradation. Due to the rapid growth of the floriculture industry, many have become concerned by the potential for adverse environmental impacts. Fertilizers and pesticides, used extensively in the industry, have been linked to negative environmental and health impacts (Getu, 2009; Gadaa, 2010).

The water resources are currently over-exploited, especially due to irrigation water extraction, as the greenhouses depend on intensive water uses from Lake Ziway. E.g. One hectare of a flower farm consumes over 900 cubic meter water per month (Organic consumers Association 2006). Some study show that about 90% of flower is made up with water. This means that exporting flower is like exporting water. (Dejeyetnu, 2012).

On the top of that, floriculture industries have been putting pressure on the water quality of the lake through discharging effluents containing chemicals directly in to the water.

The use of fertilizers and crop protection agents in horticulture and floriculture imposes an additional environmental threat which results in the pollution of water resources, eutrophication and degrading the soil quality. In addition to this, the industrial system of floriculture has been one of the driving factors of change in land use. The average size of a floriculture company farm is 12.5 hectares (about 30 acres or 0.125 km²) (FloraCulture International, 2012).

Besides, emissions of crop protection agents or their residues may accumulate in fish and other aquatic organisms, and in water fowl. Effluents from the farm are causing algal blooms around the outlet of the farm which is driven by excessive nitrate and phosphate residues. And also, pesticides from the effluent can migrate via water in to the food chain as well, ultimately being consumed by humans/ animals in food.

1.4. Research Objective

1.4.1. General Objectives

- ❖ . The general objective of this research is to assess the impact of large scale floriculture farming on the soil and water regimes of the area.
- ❖ . Predicting the rate of the soil and water quality degradation which is related to the chemical contamination of the surrounding basin depending upon the sampled large scale floriculture farm and secondary data.

1.4.2. Specific Objectives

- ❖ . Assessing the presence of agrochemicals on soil and water resources of the area.
- ❖ . To compare results obtained in samples collected in the impaired sites with Control samples.
- ❖ Mapping areas affected by large scale agricultural contaminants and detecting the physical changes of the affected area.
- ❖ . Assessing the impacts of fertilizer, pesticides, chemicals usage and intensive use of water resources in the surrounding environment.
- ❖ . Recommending sustainable and better environmental management practices.

1.5. Significance of the Research

Reports show that production of commercial crops with the use of higher dosage of chemicals leads to environmental degradation such as land, water and soil (Ali, 2006). Due to the rapid growth of the floriculture industry, many have become concerned by the potential for adverse environmental impacts. Fertilizers and pesticides, used extensively in the industry, have been linked to negative environmental and health impacts (Getu, 2009; Gadaa, 2010).

Floriculture companies often build greenhouses along lakesides to facilitate easy irrigation systems for their flowers, which threatens the availability and quality of these water resources (Jansen & Harmsen, 2011). This indicates that more focus should therefore be given to the economic and environmental impacts than to the further expansion of this sector of production. The major significance of this research is to identify the existing environmental impact (physical or environmental changes) on the area which observed recently, And also to identify the levels of soil and water contamination because of the intensive use of agrochemicals utilized by floriculture framings in the area, and also to direct the remedies for the existing environmental conditions.

2. Literature Review

Environmental degradation is the result of exploiting land-use systems without consideration of the consequences on soil and water qualities of the area. Agricultural use and management systems have been generally adopted without recognizing consequences on soil and water conservation and environmental quality, and therefore significant decline in agricultural soil quality has occurred worldwide (e.g., Imeson et al., 2006).

Floriculture, or flower farming, is a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens and for floristry, comprising the floral industry. The development, via plant breeding, of new varieties is a major occupation of floriculturists (Wikipedia, 2011). According to encyclopedia environmental health (2011) Floriculture refers to the cultivation or farming of flowering and ornamental plants for gardening and floristry, including floral design.

Floriculture crops are typically herbaceous differentiating them from nursery crops, which are typically woody. Floriculture crops include flowering plants, bedding and garden plants, foliage or house plants, fresh cut flowers, and cultivated greens.

2.1. World Cut-flower Industry

People all over the world realize that flowers enhance the quality of life and influence human feelings more than words or other gifts. Globalization, cultural exchanges, and celebrations enhancing fraternity such as New Year, Valentine's Day, Memorial Day, Mothers' Day, Fathers' Day, Christmas, and weddings have induced people globally to use flowers as a means of sharing their feelings. Above all, these celebrations have acquired one-to-one pairing with flowers in some cases, e.g. roses to Valentine's Day and carnations to Mother's Day. Increased use of flowers and ornamental plants makes marketing of flowers a lucrative business (Belwal and Chala, 2008 p. 217).

Globally, different countries participating in floriculture industry and enhancing the activities time to time. According to Brian (2009) The Cut Flower and Foliage Industry in Australia is part of the agricultural sector and engages in growing flowers and foliage for cutting and

display. In Australia Water use efficiency is an area of the highest priority for all primary production sectors including cut flower and foliage enterprises.

There is significant opportunity to increase the efficient use of water through the application of sophisticated irrigation scheduling tools and techniques as those being developed and used in Israel and Europe (Brian, 2009). Israel is also leading the world in its application of these water use efficiency measures to its production areas such as greenhouse design and automation, irrigation scheduling as well as the use of lesser quality, recycled and marginal water in cut flower growing. Effectively applying these technologies and techniques provides not only significant water savings potential but can also improve plant quality, crop yield and of course profitability (Brian, 2009). The Netherlands has also a total area of 8,149 hectares of land for flower and pot plant production. 5,365 hectares is for protected cropping and 2784 hectares for open (in-ground) production. The value of this production is Euro 3890 million from 6,807 properties (International statistics flowers and plants, 2007).

According to Belwal and Chala (2008) in 2001, the UN International Trade Centre estimated the global area of 200,000 hectares dedicated to cut flowers commanding value of USD 27 billion.

In terms of total area of production, Asia and the Pacific cover nearly 60 percent of the total world area. The key markets for flower are Western Europe, North America and Japan. The EU is the world's leading importer of flowers. The other largest importers are Germany, the USA, the UK, France, The Netherlands and Switzerland accounting for nearly 80 percent of global imports.

There are more than 30 flower farms in the Lake Naivasha region pose a number of serious ecological problems for Kenya's rivers and for the lake, including loss of water, an unsustainable increase in the population because of the laborers they have attracted, and the over pumping of water from the Lake to the flower greenhouses and a ditch where waste water drained back in to the lake. Pesticides and fungicides were plainly visible in a storage facility on the property. If action isn't taken immediately, the lake will not only be polluted, it will be drained. The pesticides applied on the farms and in the greenhouses eventually end up

in Lake Naivasha and in the ground water, endangering the areas people and wildlife, including hippos, fish and birds. There is no legal framework guiding the use of water from Lake Naivasha. The flower farms, through the Lake Naivasha Growers Association and Lake Naivasha Riparian Association, have drafted their own self regulation codes for responsible water use. Over the years, however, environmental lobbyists have raised concern over the uncontrolled sinking of boreholes to get water (Bechtet *al.*, 2006).

2.2. Ethiopian Floriculture Industry

In recent decades, the global demand for cut flowers has grown considerably. This growth in market demands and its diversification value has attracted increasing numbers of developing countries to the global fresh flower trade. These reasons seem to make Ethiopia come in to the picture of this business. But some people say that Ethiopia gives attention for this sector because the European production cost skyrocketed. European cut flower growers (especially Netherlands) have been looking to other continuities for more affordable conditions as experienced other East African countries like Kenya, Tanzania and Uganda (Laws, 2006).

An introduction of cut flower program was started in 1980/81 crop season in collaboration with GTZ by importing planting materials from Canary Islands and Holland .it has been count only two decades since it has been started but in this short time it has increased from 2 to 85 in 2000 to 2011,(Hortiflora Magazine, 2011).

Production operation for commercial purpose was commenced in 1981/82 production season in the first time at Zway state farm Next to Zway farm, DebereZeit and Tibila state farms were involved in producing fresh cut flowers.

Table 2-1: Number of floriculture farms in Ethiopia (Tamerat, 2011)

Increasing number of floriculture farms in Ethiopia								
2000	2001	2002	2003	2004	2005	2006	2007	2008
10	20	30	40	50	60	70	80	90

Even though different types of flowers are grown and exported to Europe and US market, the Climate provides nearly ideal conditions for roses. According to Afrogadda (2010) Ethiopia exports more than 80 million stems a month to 40 countries. Seventy percent go to the Netherlands, from where they are sent around the world. It also exports to Germany, Britain, and Russia and, in smaller amounts, to the United States and the Middle East. The level of production has made Ethiopia the second-largest producer of roses in Africa next to Kenya and sixth in the world after Holland, Colombia, Ecuador, Kenya and Israel.

The sector's contribution to employment and export revenue has been progressively increased over the last few years. According to the report from Ethiopian Flower Producer Association EFPA (2007) 35,000-50,000 workers are employed of which 60 percent are women. The floriculture industry contributes major share of the national economy by setting its export enhancing to 100 million USD second biggest in 2007, increase of five-fold from 2005. In 2008, Ethiopia has earned 186 million USD from horticulture exports out of which 80 percent was generated by flower (Getu, 2009). According to the report of Ethiopian Horticulture Producer and Exporters Association (EHPEA) in 2010 the revenue of the sector has grown by 25 percent from 2008, following the global economic and financial crisis (Hortiflora Magazine, 2011).

The expansion of floriculture industry in Ethiopia is highly encouraged by the availability of wide natural resources; among the resources which make Ethiopia favorable for floriculture development is water and irrigable land resources which the country has and the flower needs in abundant. Ethiopia has 122 billion cubic meter surface water, 2.67 billion cubic meter ground water, 12 river basins, 18 natural lakes including the rift valley lakes and a potential of 3.7 million hectares irrigable land (Ethiopian Horticultural Strategy, 2007).

Ethiopian rift valley lakes (Area of focus)

However, 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. The industry is blamed for using too much chemicals which damage the environment through its discharge.

The production uses more than 300 chemicals as pesticides and growth regulators, which kills useful organisms in the soil and disturbs the biodiversity (Sisay, 2007). Getu (2009) confirmed that intensive chemical fertilizers and pesticides that are frequently applied to produce a quality rose resulted in the negative impact on the environment. Intensive utilization of water resources without considering the coming consequences will lead to reduces the ground water table, as USEPA (1990) after intensive water use by floriculture, the water table has dropped under the savanna surrounding Bogota.

The recently initiated flower production areas are mainly around Addis Ababa, Upper Awash valley and Lake Ziway. Addis Ababa, the capital, with its altitude elevated about 2000 meters is the most suitable place for the production of high quality roses. Besides its suitable weather, all the infrastructures like roads, power, telecommunication and water have been availed for the investors in floriculture sector. Most of foreign and domestic investors on flower production have started their production on this area.

It is also practically witnessed that Ethiopian highlands provide “Near Ideal” growing condition for roses. In the Upper Awash Valley with an altitude spanning from the range of 1200 to 1400 meters and the farms are located along the length of the River Awash with in 149 – 220 km away from the capital. Lake Ziway which is located in the southern region of the country (165 km from Addis Ababa) the farms situated between Lake Ziway and the main highway with altitude ranges between 1600–1700m above sea level



Figure 2-1: Direct effluent discharge to the lake

2.3. Environmental Impact of the Floriculture Activities

With the expansion of the floriculture industry, there is a growing concern as to its adverse effect on the national environment. This section highlights the kinds of environmental risks; intensive water uses, uses of fertilizers, pesticides, and waste disposal systems involved, the extent of the threat and the activities undertaken by other nations to combat the risk.

2.4. Intensive utilization of water resources

One of the major nature of flower farm is it consumes a high amount of water. E.g. One hectare of a flower farm consumes over 900 cubic meter water per month (Organic consumers Association 2006). Some study show that about 90% of flower is make up with water. This means that exporting flower is like exporting water. Despite the use of high level water by flower farms, they are very reluctant to use an effective way irrigation system that will led the case much worst (Ethiopian review 2010). Recent research showed that there is a loose of natural capacity in river Awash. Since Most farms follow the step of the Awash River valley or its tributaries around the Great Rift Valley in order to take their positional advantage to proximate themselves to the capital city, Addis Ababa, in which the main cargo flight service is located. This led to rivers and lakes to lose their natural capacity due to high water consumption. In this region particularly there are a lot of local farmers who are dependent on water for their crop cultivation and cattle breeding.

Decreasing of water level of those lakes and rivers in which their life is dependent on made them to frustrate, instable and finally put their future livelihoods in danger. Considering Kenya's flower industry as a reference, still conflict going on by a concerned local people and flower farm investors those who depends their live in Lake Navisha.

There is a clear procedure on Ethiopian legislation bodies and EPHEA about how much water a single farm should use per area. However, the water level is dropping from time to time and there is no action is implemented to tackle this problem. In the future, water expected to displace oil as the greatest resource challenge, and Water is central thing for survival and without it, life would be impossible. Water is a central component of Earth's ecosystems, providing important controls on the weather and climate and it should be given a high consideration for conservation.

2.5. Fertilizers used in floriculture framings

Fertilizers are used in many different forms of agriculture to increase the level of crop production by adding nutrients to the soil that benefit the growth of plants (Federal Environmental Protection Authority, 2012a). However, they are often harmful to the environment (Getu, 2009). The only alternative to chemical fertilizers is the use of organic methods, which can be timely and costly, but less harmful to the environment (Pimentel, Hepperly, Hanson, Douds, & Seidel, 2005).

In the floriculture industry, fertilizer demand is especially high due to the year-round production of flowers (Hengsdijk & Jansen, 2006). Dutch fertilization standards for roses cultivated under artificial light require 1,190 kilograms of nitrogen (N) per hectare, and 280 kilograms of potassium (K) (Hengsdijk & Jansen, 2006).

Crops do not absorb all the fertilizers that are applied, and much of the excess fertilizer runs off into the Rift Valley Lake water systems (Federal Environmental Protection Authority, 2012a). The residue of these fertilizers can cause water pollution, eutrophication of fresh waters, and increased nitrate concentrations in ground and surface waters (Federal Environmental Protection Authority, 2012a).

The long-term use of inorganic fertilizers can also be detrimental to the soil because it can kill nitrogen-fixing bacteria and other beneficial organisms (Pimentel et al., 2005). As a result, more fertilizers are applied each year to make up for the loss of natural microorganisms and micro-nutrients (Getu, 2009).

Additionally, fertilizer use can have negative health implications. The excessive use of nitrates has been linked to the blood disorder methemoglobinemia, commonly known as blue-baby syndrome, which occurs when people drink water that is contaminated with excess nitrates (Federal Environmental Protection Authority, 2012a; Getu, 2009; World Health Organization, 2012). Excess nitrates interfere with the oxygen carrying capacity of the blood, and have also been suspected as a carcinogen (World Health Organization, 2012).only a few of the undesired impacts discussed below.

2.5.1. Effects on Health

Many are interested in the health of workers and growers in the floriculture sector. In recent years, the industry and governmental agencies have taken steps to make floriculture farms safer work environments, because a sick worker is both a direct and indirect cost to the grower. Many companies believe in providing and enforcing the use of protective gear when spraying chemicals (Nigatu, 2010; Tamrat, 2011). Supplying protective gear is obligatory as to protect the workers as best they can; additionally, many growers have chemical vendors conduct training sessions about the proper application of chemicals (Tamrat, 2011; Nigatu, 2010). If the workers do have health problems there are several medical personal at a nearby hospital in Ziway who serve flower farm employees and their families for free (Tamrat, 2011).

2.5.2. Effects on Soil

A growing crop does not take up all the nutrient ions in the fertilizer applied to the soil. Generally, healthy soil contains enough nitrogen fixing bacteria, which fixes sufficient atmospheric nitrogen to supply the needs of the growing plants.²⁵ But continued use of chemical fertilizers may destroy these nitrogen-fixing bacteria and many other micro- and macro- organism of the soil. In addition, acid in chemical fertilizers, such as sulfuric acid and hydrochloric acid, which tends to increase the acidity of the soil, reduces the soil's beneficial organism population and interferes with plant growth.

2.5.3. Effects on Aquatic Life

There are many fertilizers, which leak through the soil to the ground water or ditches and streams, thus causing water pollution. In a process known as *eutrophication*, fertilizer washed from fields into surface waters stimulates algae growth, which blocks sunlight needed by aquatic vegetation putting their survival at stake. This loss in vegetation disrupts the food chain, leading to the death of economically important aquatic life. Moreover, this causes depletion of oxygen found in the water thus degrading the quality and usability of the water.

2.5.4. Effects on Atmosphere

Some fertilizers, like Urea, spread in the fields with the help of sprayers and the ammonia therein react with the water present in the air causing the formation of ammonia oxide, and hence air pollution.

2.6. Pesticides used in floriculture framings

Floriculture is prone to pests, weed attacks, and fungal diseases; therefore, pesticides are widely used to reduce pest and disease pressure (Hengsdijk & Jansen, 2006). However, less than 0.1% of applied pesticide reaches the target pest, while the other 99.9% is a pollutant to the environment, much of which leaches into water bodies (Getu, 2009; Pimentel, 1995; Sabik, Jeannot, & Rondeau, 2000). Target pesticides kill many beneficial flora and fauna, which normally help kill other pests, pollinate plants, and build organic matter in soil (Pimentel, 2005; Getu, 2009). Frequent use of pesticides can also lead to health problems. Chronic health effects such as cancers, reproductive disorders, and birth defects have been linked to pesticides (Andersen et al., 2008; Haylamicheal & Dalvie, 2009; Winchester, Huskins, & Ying, 2009). Pesticide residues can also accumulate in fish and aquatic organisms, threatening food chains and human health alike (Hengsdijk & Jansen, 2006)

a) Water

Pesticides can move from the site of application via drift, volatilization, leaking, and runoff. Pesticides, including herbicides, can and do leak to contaminate ground water. Once ground water is polluted with toxic chemicals, it may take many years, a huge expense and a complex process for the contamination to be cleaned up. As a result, the contamination (by pesticides) of ground and surface water, which supplies the greatest part of drinking water, is a serious problem worldwide. When pesticides contaminate water, they can be harmful to the fish and other marine or freshwater animals that live there.

b) Soil Organisms

Soil is a dynamic living system with a variety of micro- and macro- floral and faunal species including *bacteria*, *actinomycetes*, *fungi*, *nematodes*, *arthropods*, *crustaceans* and *earthworms*.³⁸ These flora and fauna play a primary role in the degradation of plant and animal residues and other organic matter in the environment as well as in nitrogen fixation,

nitrification and the release of nutrients from soil minerals.³⁹ Anything that affects their activities in turn affects the function of soils in crop production, and in the global carbon and nitrogen cycles.

c) Pesticide Resistance

The extensive use of pesticides has resulted in the development of pesticide resistance in many insect pests, plant pathogens, weeds, and rats. Worldwide, more than 500 insect and mite species, more than 150 plantpathogen species, and more than 275 species of weeds have become resistant to herbicides. The estimated cost of pesticide resistance in pests in the United States, for example, is estimated to reach \$1.4 billion annua

d) Non – Target Organisms

The effect of pesticide on non-target organisms is also immense. It has been reported that about ten million non-target organisms including thousands of domestic animals are poisoned each year throughout the world.⁴³ Moreover, it destroys the population of natural enemies, whose destruction and lack of biological control in agriculture, result in food loss due to pests which can increase by as much as fifty-eight percent. ⁴⁴ Pesticide use also has an adverse effect on the pollination process as honey and wild bees are vital for pollination of about one-third of fruits, vegetables, and other crops worldwide.⁴⁵ Wild birds and mammals are also hurt by the application of pesticides. ⁴⁶ The ethical issue that arises at this juncture is the extent to which it is justifiable to destroy thousands of species for the purpose of killing the “harmful” few.

e) Air Pollution

Many pesticides can volatilize (that is, they can evaporate from the soil and foliage, move away from the area of application, and contaminate the environment). As much as 80-90 percent of applied pesticides can be increase by as much as fifty-eight percent. Pesticide use also has an adverse effect on the pollination process as honey and wild bees are vital for pollination of about one-third of fruits, vegetables, and other crops worldwide. Wild birds and mammals are also hurt by the application of pesticides.

The ethical issue that arises at this juncture is the extent to which it is justifiable to destroy thousands of species for the purpose of killing the “harmful” few. Volatilized within a few days of application. Research conducted in the US shows the availability of pesticide residues in air. Accounting for all of these effects, a conservative estimate of the total damage to the environment and public health caused by pesticides is about \$9billion each year. Research is not available to show how much of this impact is contributed by the floriculture sector, but it is obvious that the sector usually uses more fertilizer than conventional farming.

According to Abiy (2013) while development has been reported in application of chemicals largely due to awareness of workers, pressure from labor unions within the farms, and directives of the Ministry of Agriculture, there are still some hazardous chemicals that are still in use.

2.7. Waste Disposal

Floriculture activities produce different types of waste ranging from liquid to solid, hazardous to non-hazardous, and in effect require safe waste disposal and differentiated treatment. Empty chemical containers (fertilizers, pesticides) and their washing waters and obsolete chemicals are the major spheres of concern in addition to which other agricultural waste such as cutoff crop parts, unused soil, and waste water are generated in the sector.

3. Methodology

3.1. Study Design

3.1.1. Site selection

A reconnaissance survey has been conducted around the lake area to identify the sources of effluents, each waterway pipe discharge 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, four points were chosen along the greenhouses to assess the concentration of physicochemical, nutrients, and oxygen demanding parameters. Moreover, Land sat images have been used to analyze of Land use/ Land cover change.

3.2. Sampling

3.2.1. Water and Soil Sampling

Samples are taken from water and soil regimes of the area. The sampling sites were located by using GPS (Global Positioning System) and accurately marked on the map Water sample is taken from the lake and was done by direct immersion of the polyethylene vessels in to the lake from four different sites, and soil samples taken from four different sampling sites adjacent to the floriculture farming.

3.3. Analytical Method

Water samples were collected and analyzed for PH, electrical conductivity (EC), Turbidity, Total suspended solids (TSS), Total dissolved solids (TDS), Nitrate nitrogen (No₃-N), orthophosphate (PO₄³⁻), Dissolved Oxygen (DO), Biological oxygen demand (BOD), chemical oxygen demand (COD), parameters at ministry of water resources.

The turbidity of the water is determined photo electrically using photometer and digital turbidity meter. The meter is calibrated using standard samples, once the meter is calibrated to correctly read these standards; the turbidity of the water sample was taken. Total hardness was determined by a complex metric titration using a standard acidsolution. PH was measured using JENWAY model 3510 PH meter;

TDS and EC were measured using JENWAY model 470 conductivity meter. Vacuum pump was used to measure TSS. Nitrate-Nitrogen, orthophosphate, Potassium, Calcium, magnesium and Sodium were all analyzed by using HACH spectrophotometer Model DR/2400 in accordance with the HACH procedural manual (HACH, 1999). 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 APHA (1998) instruction.

The methods of analysis for water pH is potentiometric, the COD is analyzed by open reflux method, the EC is also analyzed by potentiometric method, SO₄ and PO₄ is analyzed by colorimetric method which is used the instrument called spectrophotometer to read the color strength and total nitrogen is analyzed by persulphate method.

The soil sample is taken to analyze the following parameters pH, CEC, EC, Phosphorus (P) and total Nitrogen (TN). The methods of analysis for soil sample total nitrogen is Kjeldahl method, the CEC is analyzed by Ammonium acetate method, Phosphorus is analyzed by Alkaline Phosphomolybdate method, and the pH is measured by pH meter and the EC is measured by Electron

3.3.1. Data Analysis Method

The data collected for this study were analyzed using Statistica Analysis System, for variation in physicochemical, pH, CEC, EC, Phosphorus (P) and total Nitrogen (TN) Nitrate (NO₃-N), reactive phosphate (PO₄), Biological oxygen demand (BOD), chemical oxygen demand (COD), Total ammonia (T-NH₃) concentrations in the soil and water.

- For the water samples three approaches have been used to evaluate the contamination.
 - 1, Results at the impaired sites have been compared with the control sites.
 - 2, Results of physicochemical parameters were compared with water quality standards of EPA, WHO, FAO to check whether the results are to check whether the lake water is within the acceptable range for irrigation and at the permissible limits for drinking water, maintenance of fishery and other domestic uses.

3, comparisons have been made between the cumulative results of the research conducted on the same area with similar sampling points, which showed similar climatic conditions and seasonal variations from NOV to April.

- The results of physicochemical parameters of a soil were compared with the Ethiopian EPA and FAO provisional standards to check whether the effluent and floricultural chemicals are within the stated standard and to evaluate impacts on the physical and chemical properties of the soil.

4. RESULTS AND DISCUSSION

Based on the results of physicochemical parameters I have developed a set of criteria to evaluate the large scale floricultural activities from the major environmental issue and environmental impact perspective. Among the environmental issue, I have identified three major criteria's and three major environmental impacts as a quenciqunce (Table4.1).

Table 4-1: Identified Environmental Criteria and Environmental impact

No	Major environmental issue	Physicochemical parameters	Major environmental impact,
1	water contamination	EC,PH,TDS,TSS,NO ₃ ,SO ₄ ,NH ₃ ,PO ₄ , BOD,COD,DO,(micronutrients	Water quality degradation
2	soil contamination	EC, PH,CEC,TN,P	Soil quality degradation
4	Environmental resource utilization, Land use/land coverchanges	-analyzing land sat images of 1973,1986,200and2013	Large agricultural area, Intensive irrigation and unsustainable soil use Increased erosion and run-off.

4.1. Water contamination (impact of chemicals on Lake Ziway)

Water samples were collected and analyzed for PH, electrical conductivity (EC), Turbidity, Total suspended solids (TSS), and Total dissolved solids (TDS), Nitrate nitrogen (No₃-N), orthophosphate (PO₄³⁻), Dissolved Oxygen (DO), Biological oxygen demand (BOD), chemical oxygen demand (COD), parameters at ministry of water resources.

Table 4-2: values of physicochemical parameters at four study sites.

Parameters	Sampling sites			
	SSW1(control)	SSW2	SSW3	SSW4
Turbidity	94.90	21.9	37.36	41.25
Suspended solids	110	36.00	40	48.
TDS105°C(mg/l)	292	1116	694	688
OD	2.95	4.60	5.21	2.77
Electrical Conductivity, EC (µs/cm)	507	1874	1009	1007
PH	7.97	7.82	7.90	7.90
Total ammonia	0.57	1.54	0.69	0.76
Nitrate	0.16	0.070	2.107	2.20
Nitrite(mg/l NO3)	3.17	1.09	12.99	12.45
Sulphate(mg/LS	18.13	65.73	74.20	71.15
Reactive phosphate (PO4)	0.39	0.09	0.18	0.57
BOD(mg/l)	317.2	291.2	306.8	348.4
COD(mg/l)	700	500	600	900
Total Nitrogen	0.001	0.001	Trace	0.001

4.1.1. EC and pH

The electrical conductivity of the lake may increase due to the ions from fertilizer and pesticides which are directly discharged to the water body, the EC values are significant increase at the impaired sites and even exceeded the standards of (EPA, 2003) the optimum EC for lake is 100-1000(µs/cm). According to FAO water quality guidelines, electrical

conductivity values less than $700 \mu\text{s}/\text{m}$ has no potential irrigation problem but values between $700\text{-}3000 \mu\text{s}/\text{m}$ could create slight to moderate problems on irrigated lands. EC estimates the amount of total dissolved salts or the total amount of dissolved ions in the water. High electrical conductivity indicates the risk of salinity of the lake.

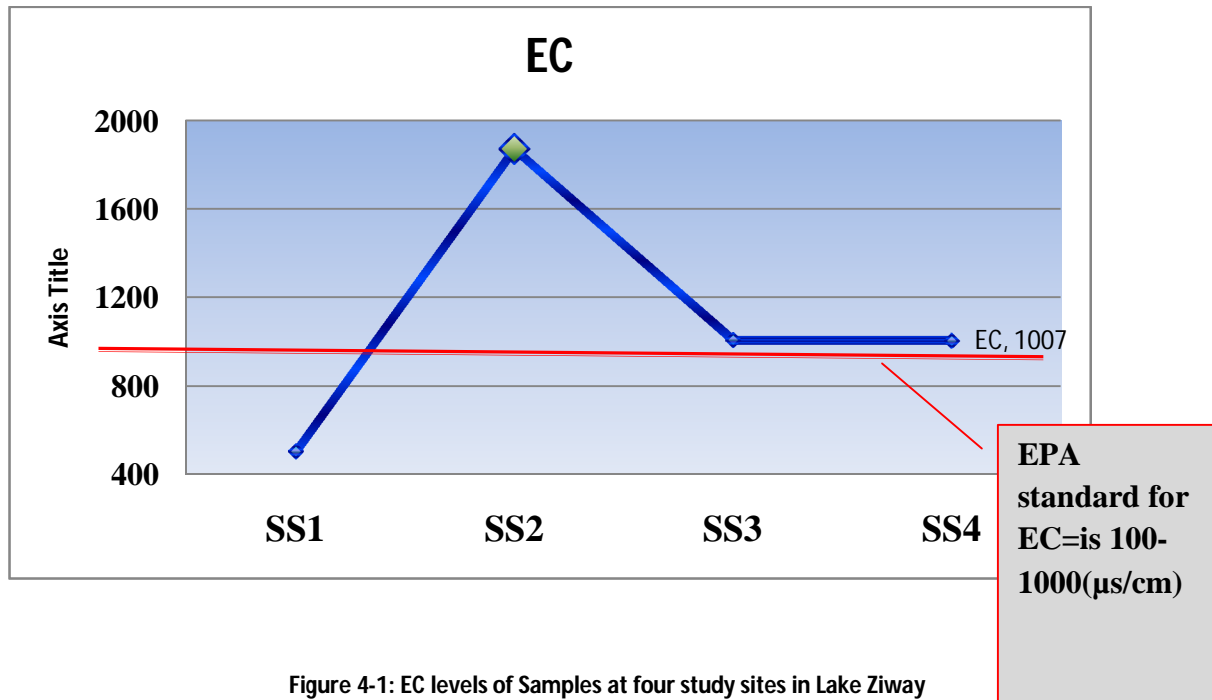


Figure 4-1: EC levels of Samples at four study sites in Lake Ziway

The PH of lake Ziway is neutral to slightly alkaline due to the geology and rocks of the surrounding catchment, this makes average PH of Lake Ziway is around 8.5. Even though the cumulative result falls between the ranges of the standards (6.5-8.5).it showed slight difference between the control and impaired sites (Table4) these gradual reduction in PH value affects the solubility of nutritive chemicals; as a result, the availability of these substances to aquatic organisms is increased. This could create unfavorable environment for fish and other aquatic organisms in the lake (Barnes *et al.*, 1998)

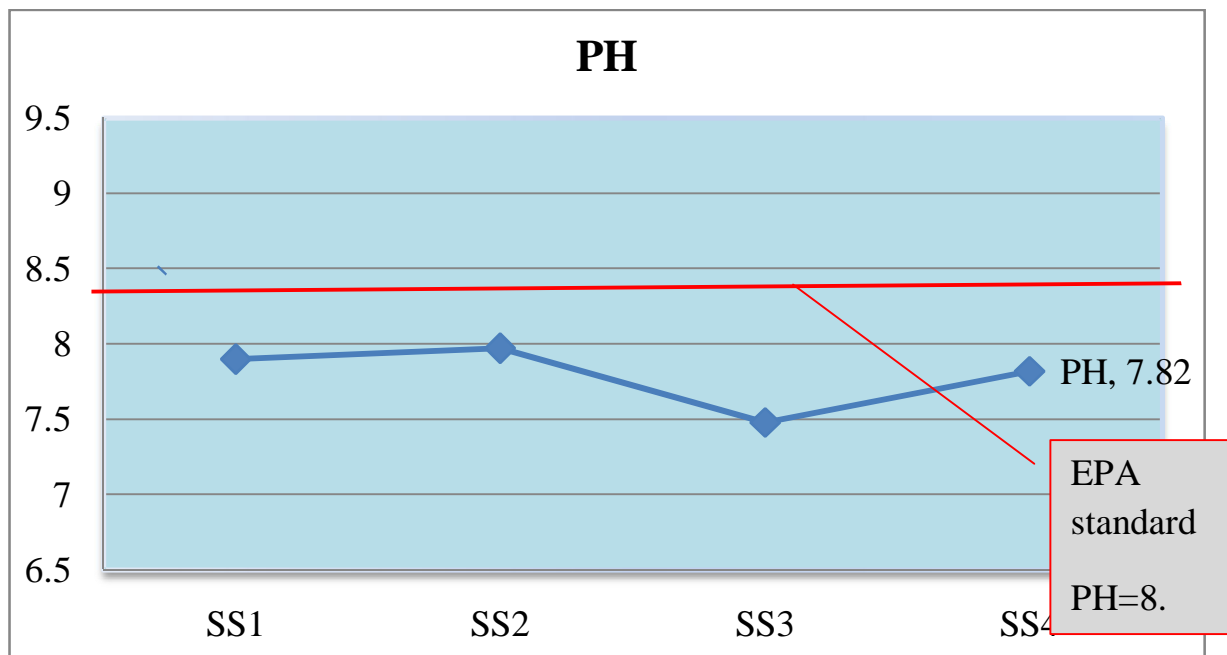


Figure 4-2: Values of PH at five study sites in Lake Ziway

4.1.2. Biological Oxygen Demand

Organic wastes from the farm effluent act as a food source for water born bacteria. Bacteria decompose these organic materials using dissolved oxygen, thus reducing the dissolved oxygen which is present for fish. The difference in the concentration of BOD 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 (Malefia, 2009).

BOD values in both the control and impaired sites found to be above the limit of the guideline. According to EPA (2003) the optimum BOD for lake water is < 5 mg/l Ethiopia for fisheries and aquatic life (FEPA, 2003) and mostly unpolluted streams have a BOD that ranges from 1 to 8 mg/l (USEPA, 1976).the cumulative results also been compared with the research conducted on this lake by Malefia (2009) and significant increment has been encountered. In 2009 the cumulative result of BOD was 25.2 and It is now increased by 292.8(mg/l).

The result indicates that the rate of BOD increases with an increasing time and high risk for aquatic life. This could be due to excessive organic and inorganic wastes in the farm effluent (Gordon et al., 1992).

4.1.3. Chemical Oxygen Demand

COD is a measure of the total quantity of oxygen required to oxidize all organic material in to carbon dioxide and water. Similarly the average result of COD of Lake Ziway has highly significantly increased and exceeds EPA standard.

The optimum COD for lake water is < 150 mg/l (EPA, 2003). Similarly when comparing the cumulative results which have been, conducted on the same area; it shows significant increment which a range from to 107 mg/l to 675 mg/l, the amount is enhanced by 568 mg/l; it indicates how the volume of effluent from floriculture farms is increased from time to time and affecting the lake.

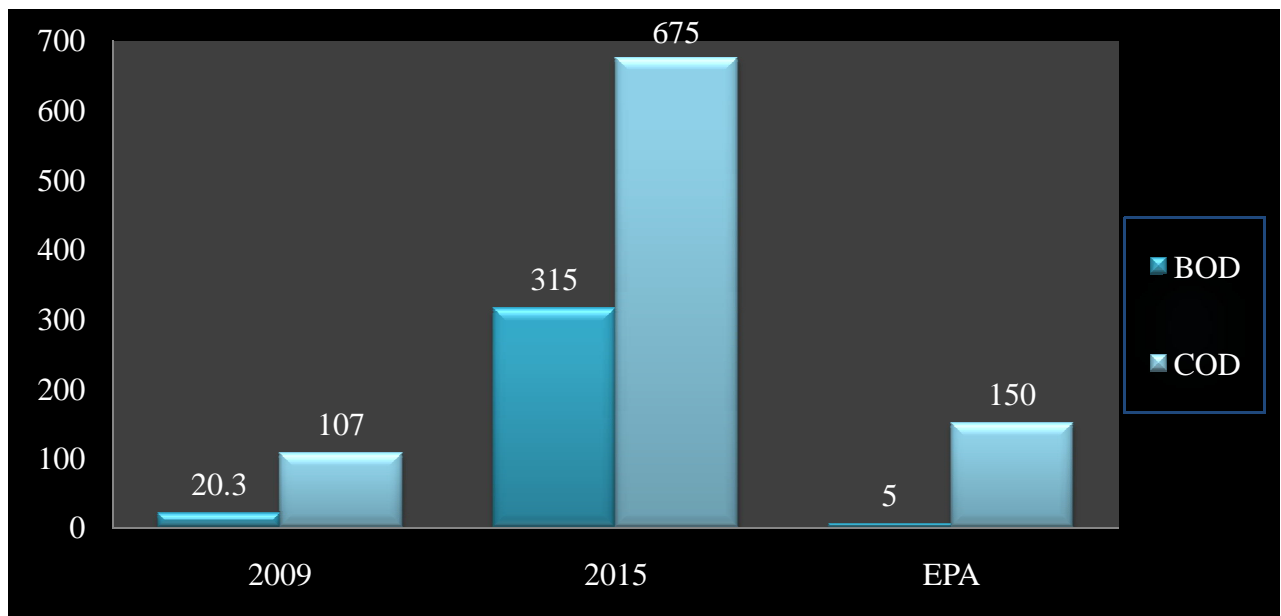


Figure 4-3: BOD and COD results at different time with respect to Ethiopian EPA

4.1.4. Oxygen Demanding Parameters

The oxygen dissolved in Lakes, rivers, and oceans is crucial for the organisms living in it. As the amount of dissolved oxygen drops below the normal levels in water bodies, the water quality is harmed and aquatic organisms begin to die off (Barnes *et al.*, 1998).

The values of DO were compared with US-EPA standards and the level of dissolved oxygen both in the control and impaired sites were below the standard values. Studies indicate that; this might be due to the speed of the water flow, when the movement of the water is slow,

there will be less aeration. Besides, bacteria in water can consume oxygen as organic matter decays. In addition to that the reduction of dissolved oxygen level at the lake could be due to nutrient enrichment from the farm effluent which promotes excessive growth of algae and aquatic vegetation; when the vegetation decomposes the level of dissolved oxygen decline

Table 4-3:levels of dissolved oxygen and EPA standard for fish

Dissolved oxygen and EPA standards for fish life		
1	DO levels < 2	will not support fish
2	DO levels < 3ppm	stressful to most aquatic organisms
3	DO= 5-6 ppm	support growth and activity of most aquatic organisms

The levels of dissolved oxygen at the impaired and control sites were < 4ppm ;(Table4.3) this might indicate that the lake water around the farm is becoming unfavorable for supporting aquatic organisms. Fish, invertebrates, plants and aerobic bacteria all require oxygen for respiration. As the dissolved oxygen level decrease in the water, fish and invertebrates living in the lake will be affected. In Lake Ziway, fish stocks are declining around the outlet of the farm effluent directly to the lake, this might be due to reduced levels of dissolved oxygen.

4.1.5. Nitrate NO₃ (nutrients)

In the study area the concentration of nitrate at SS3 and SS4 are beyond the standard limits. But in the control site it is relatively within the standard limit. Hence, the ambient standard to protect aquatic ecosystems is 10 mg/l (EPA, 2003). The main Sources of nutrient in the area is the intensive use of Nitrogen concentrated fertilizer and direct effluent discharge by the flower farms. Plants do not absorb all the fertilizers that are applied, and much of the excess fertilizer runs off into the Rift Valley Lake water systems (Federal Environmental Protection Authority, 2012a). The residue of these fertilizers can cause water pollution, eutrophication of fresh waters, and increased nitrate concentrations in ground and surface waters (Federal Environmental Protection Authority, 2012a).

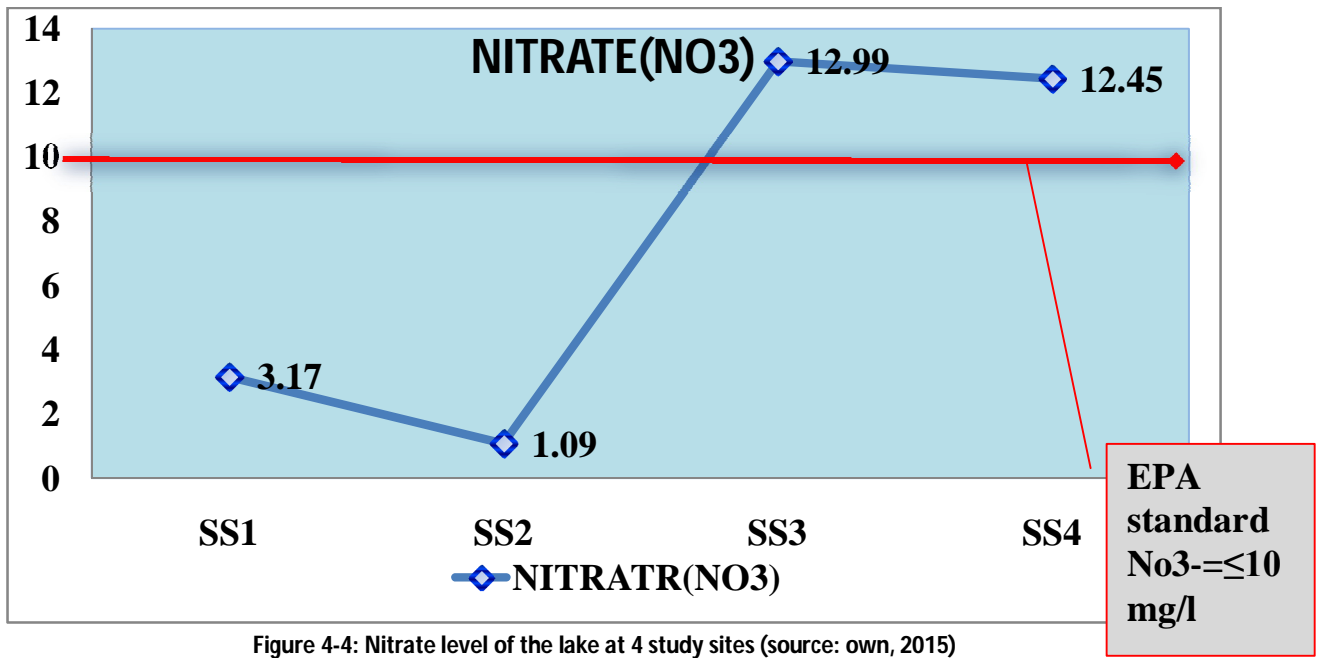


Figure 4-4: Nitrate level of the lake at 4 study sites (source: own, 2015)

4.1.6. Phosphate PO₄

Floriculture industries are known for using excessive fertilizers and the effluents from the farm drained directly to the water body. Excessive amounts of phosphorous in a system can lead to an abundant supply of vegetation and excessive growth of algae, consequently low dissolved oxygen.

The total phosphate of lake is 1.23 mg/l and the EPA (2003) provisional standard for PO₄³⁻ is 0.005mg/l and the standard for Phosphates should not be exceed from 0.1mg/l in any lake (Hyland *et al.*, 1993. This all shows that the lake is highly concentrated by phosphate and exposed to emerging of phytoplankton that leads to eutrophication.

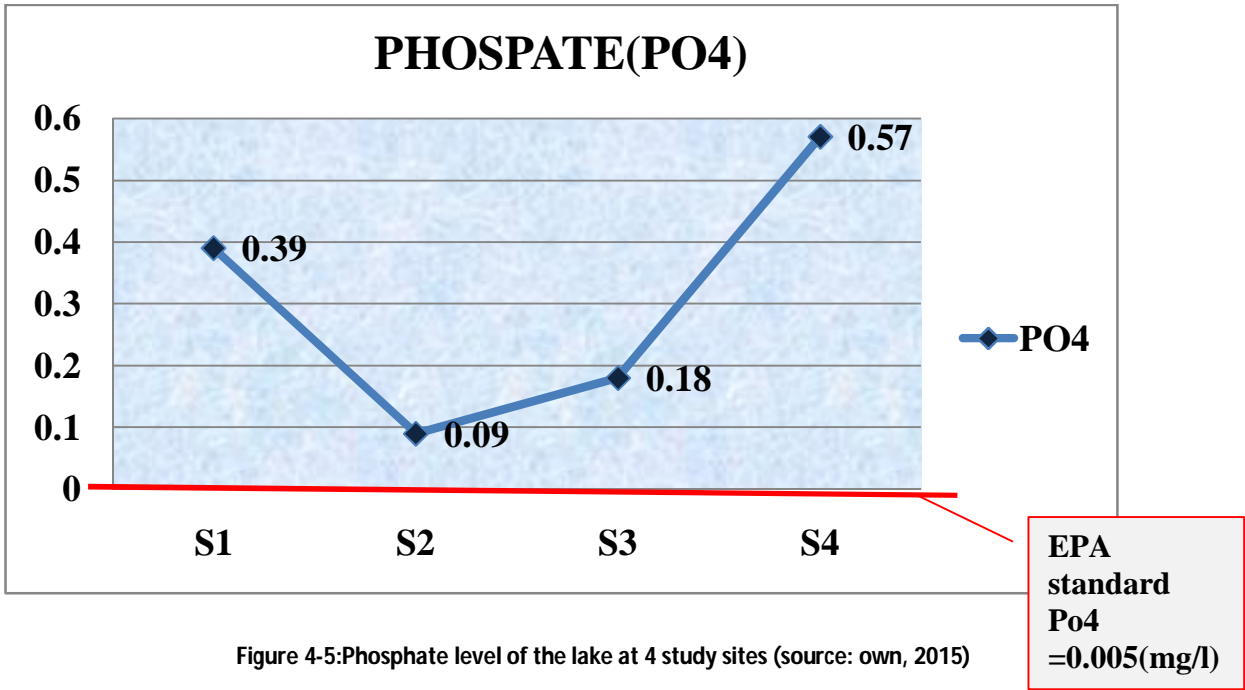


Figure 4-5: Phosphate level of the lake at 4 study sites (source: own, 2015)

4.1.7. Total Ammonia T-NH3

The total ammonia of Lake Ziway showed slight difference between the control and impaired sites the standard states by EPA (2003) the optimum NH₃-N for lake water is < 0.025 mg/l. However, the value ranges between 0.57-1.54 and increases at the downstream area; which is closer to the floriculture farm, which might be the source of excess nutrient due to fertilizer use and filled the lake with ammonia beyond the standard level.

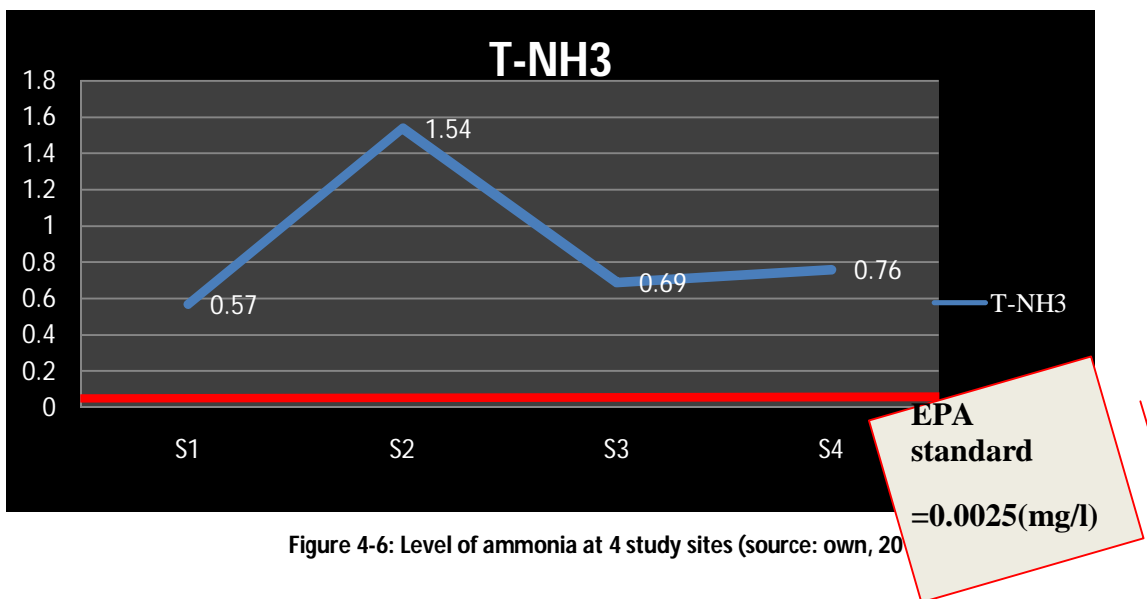


Figure 4-6: Level of ammonia at 4 study sites (source: own, 2015)

4.1.8. Sulphate

Significant increase of sulphate is found at the impaired sites when comparing with the control sites, moreover, the results indicate that there is a high concentration of sulphate in the water which is >20ppm.

Table 4-4: concentration values of Sulphate at four sampling sites of the lake

Soil test sulfate-S (ppm)	
very low	<2
low	2-5
medium	5-20
high	>20

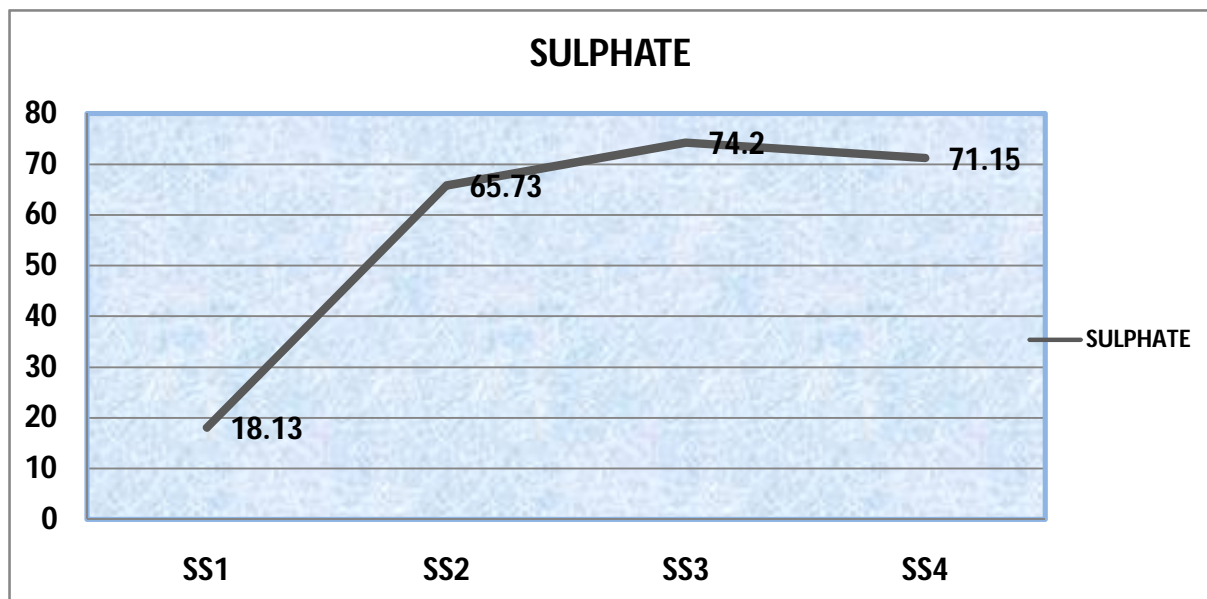


Figure 4-7: Levels of sulphate at for sampling sites of the lake

4.1.9. Total Dissolved Solids (TDS)

Total dissolved solid values showed significant differences between the control and impaired sites were relatively greater at SS2 and (Table4); this could be due to the farms around these sites discharged untreated effluents in to the lake which led to a negative impact on the lakes

water quality. TDS value between 450-2000mg/l has slight to moderate irrigation problem and the values of TDS at Lake Ziway were between these ranges. Except the control, mean values of TDS were above the water quality guidelines.

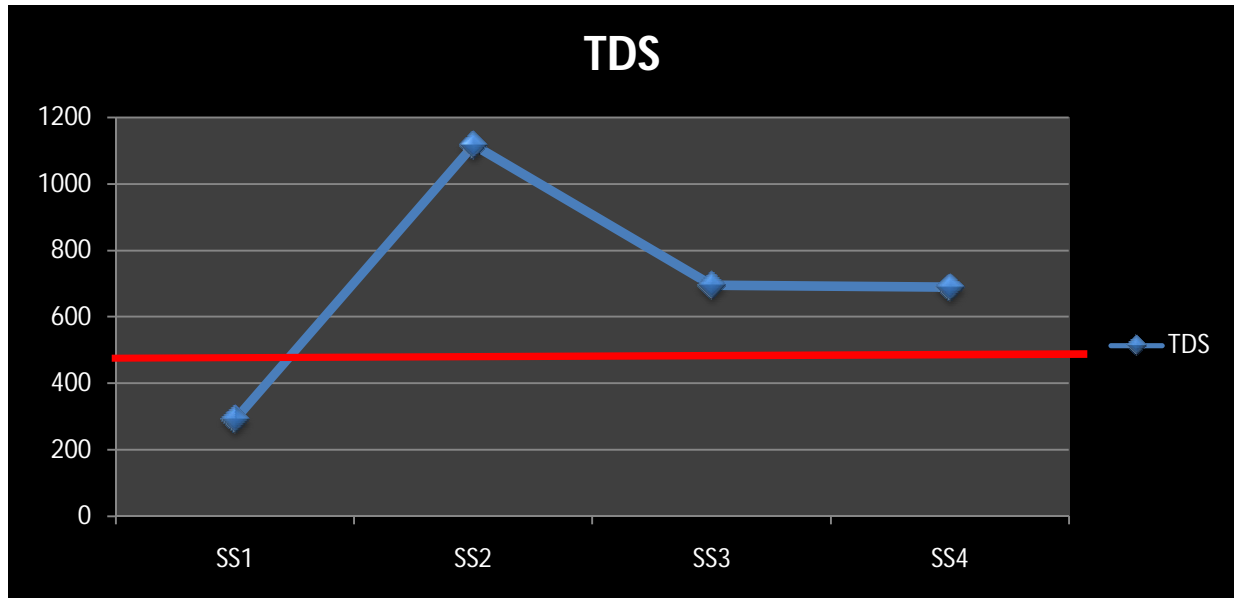


Figure 4-8: Values of TDS at 4 study sites of the lake Ziway (Source: own, 2015)

4.1.10. Turbidity and Total Suspended Solids

Turbidity is the amount of particulate matter that is suspended in water. Turbidity or cloudiness in water is caused by suspended materials that scatter light passing through the water. In addition to blocking out the light needed by submerged aquatic vegetation Based on this classification, the lake water around the farm was slightly cloudy and aquatic life in this water could be threatened. Total suspended solids (TSS) values are generally above WHO permissible limit (25mg/l) and excessively high compared to other reported values in the region.

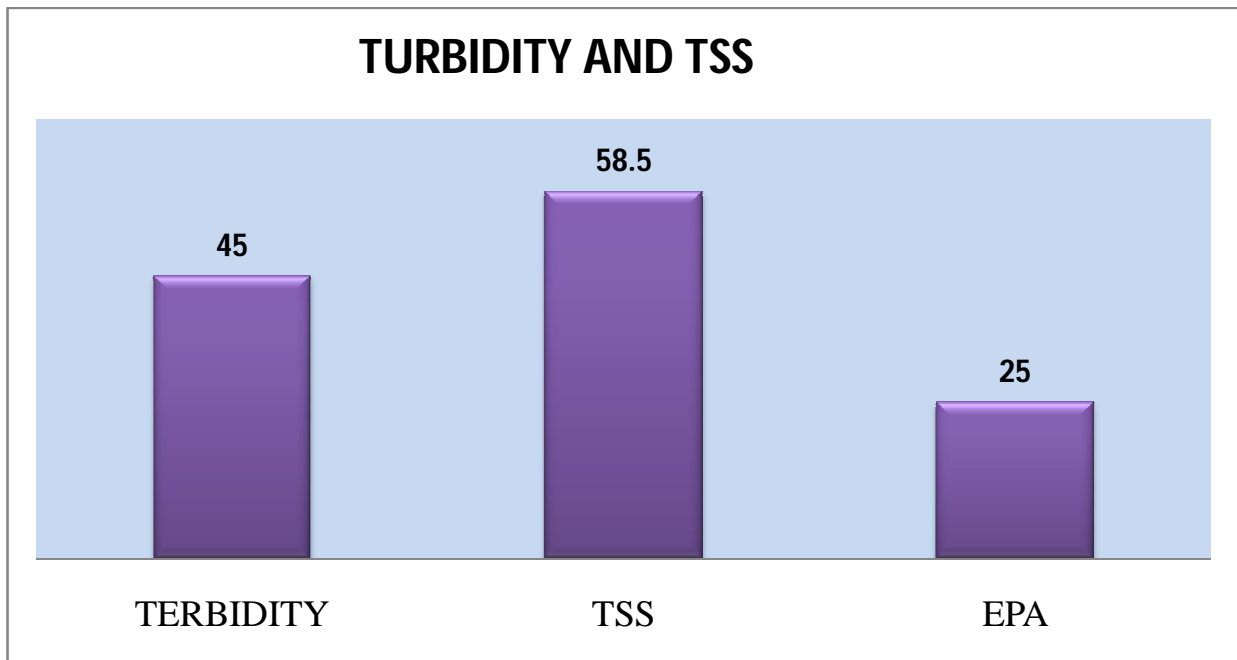


Figure 4-9: Average values of turbidity and TSS at Lake Ziway. (Source: own, 2015)

4.2. Water quality degradation of Lake Ziway

Many of the lakes near floriculture greenhouses are endorheic (Ramsar, 1992), which can be problematic because of high levels of water pollution. With the development and expansion of irrigated agriculture, however, man's activities are greatly contributing to the build up and spread of salinity problems. According to (Tadelle 1993) the freshest lake (Ziway) which falls within the main rift valley area has been targeted in particular for substantial irrigation development by the government since the 1970's, by taking water directly from Lake Ziway and its two feeder rivers Katar and Meki river.

The floriculture industry puts significant pressure on Lake Zeway, by drawing water for irrigation as well as releasing waste water containing pesticide and fertilizer residue back into lakes (Jansen & Harmsen, 2011) In most of the physico-chemical parameters of Lake Ziway the analysis, results fell above the limits set by WHO, EPA, and other water quality regulating bodies like TNU. In addition to this, there is a growing concern that the rate of contamination is increasing from time to time. The table below clearly shows the increasing trend of contaminants and impacts to the surrounding environment.

Table 4-5: Comparison of cumulative sample results at different time table

No	parameter	2009	2015	EPA/WHO	REMARK
1	Turbidity	31.32	48.85	<25mg/l	Increased within this years and it is beyond the standard limit
2	Suspended solids	0.094	58.5	<25mg/l	It showed significant increase. And affects aquatic species.
3	TDS105C(mg/l)	470.4	697.5	>450mg/l	Slight to moderate irrigation problem
4	OD	1.60	3.88	<4ppm	Stressful for most aquatic organisms
5	Electrical conductivity, EC (µs/cm)	829.8	1009	700-1000	Slight to moderate irrigation problem
6	PH	8.64	7.89	6.5-8.5	PH showed a decreasing trend which lead to acidity and nutrient solubility
7	Nitrate (mg/l NO3)	24.5	7.46		Comparing with previous it has decreased but still is below the standard
8	Reactive phosphate(po4)	3.60	0.30	0.005(mg/l)	Comparing with previous it has decreased but still is below the standard
9	BOD(mg/l)	20.21	315.9	< 5 mg/l	significantly increased within five years and affects aquatic life
10	COD(mg/l)	111	675	<150 mg/l	significantly increased with time and high risk for aquatic life

4.3. Soil contamination (Results of physicochemical Analysis of a soil (pH, Phosphorus (P), Electrical Conductivity (EC), Cation Exchange Capacity (CEC), And Total Nitrogen

The result of this study reveals the existence of soil contaminants in the study area from the laboratory analysis of four-soil samples. The presence and level of chemicals coming from fertilizers, pesticides and all crop protection agents in the study area was categorized based on five main parameters of affected soils such as EC (electrical conductivity), pH, CEC (cation exchangeable capacity), p (phosphate) and total nitrogen.

Table 4-6: the PH, CEC, EC, P and TN and ExcC. (Ca, Mg, K, Na) values for soils at four sampling sites.

Parameters	Sampling sites			
	S1	S2	S3	S4(control)
pH	10.53	10.25	8.63	6.48
CEC (c mol/kg)	16.94	15.37	22.20	64.90
EC (μscm^{-1})	8.78	1.65	1.01	0.37
P (mg/kg)	29	5.49	26.50	5.02
TN (%)	0.04	0.03	0.12	0.78
OC	0.41	0.25	1.19	7.17
Exchangeable cation(Ca&Mg)	6.79&2.09	4.39&2.11	3.30&2.55	32.53&13.34
Exchangeable cation(K&Na)	28.51&8.50	12.57&4.69	12.81&5.61	2.81&1.37

CEC=Cation exchange Capacity EC=Electrical Conductivity TN=Total Nitrogen

ExcC=Exchangeable Caion

4.3.1. PH

The PH values showed significant difference between the control and impaired sites, as a result of this variation and increasing in the values of PH. Most plants grow well in soils with pH values between 6.0 and 8.0. Vegetables generally do well in soils 6.0 (Moderately acid) to 7.2 (slightly alkaline).

Deficiencies can occur in soils with pH values greater than 8.0, which could decrease the solubility of many compounds particularly phosphates and elements like manganese, Zinc, Trace element (e.g., iron), copper and boron (UNEP, 2001) (Annex1). The soil chemical properties were found to be significantly influenced by the effluent because the samples (S1&S2) Table4 which taken close to flower farms showed significant increase comparing with control sites,

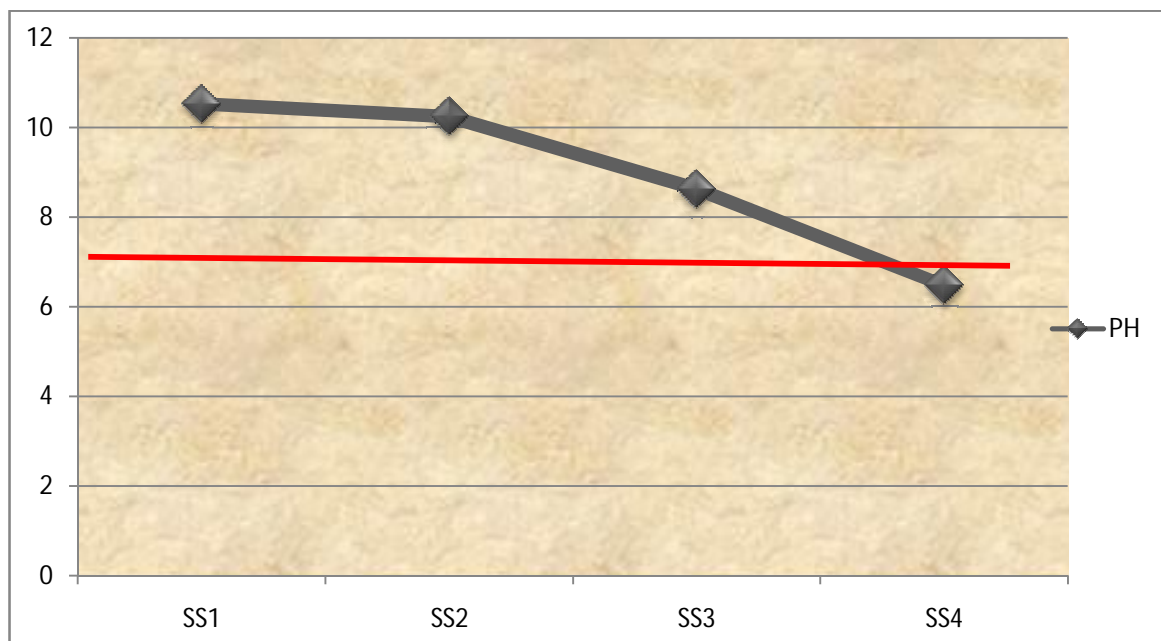


Figure 4-10: PH values of a soil at four sampling sites

4.3.2. Electronic Conductivity (EC)

EC values showed an increase in S1 & S2 respectively. When the amounts of EC increases the exchangeable elements of the soil increases therefore the salinity of soil become high, this might be the continuous usage of fertilizer and pesticide, in order to improve the fertility of a soil shortly. According to Patterson (1999), any effluent having pH and EC higher than 7.0 and 1000 μScm^{-1} respectively could affect the physico-chemical properties of soil. In this work, the pH and the EC was higher in the effluent standard therefore, it will affect the soil properties.

Table 4-7: Different value of electrical conductivity with its corresponding plant Response

EC (dS/m at 250c)	Plant response
<2	Little, no effect on the growth and yield of plants
2-4	Affects only very sensitive plants
4-8	Affect many plants
8-16	Affect tolerant plants
>16	Affects even very tolerant plants

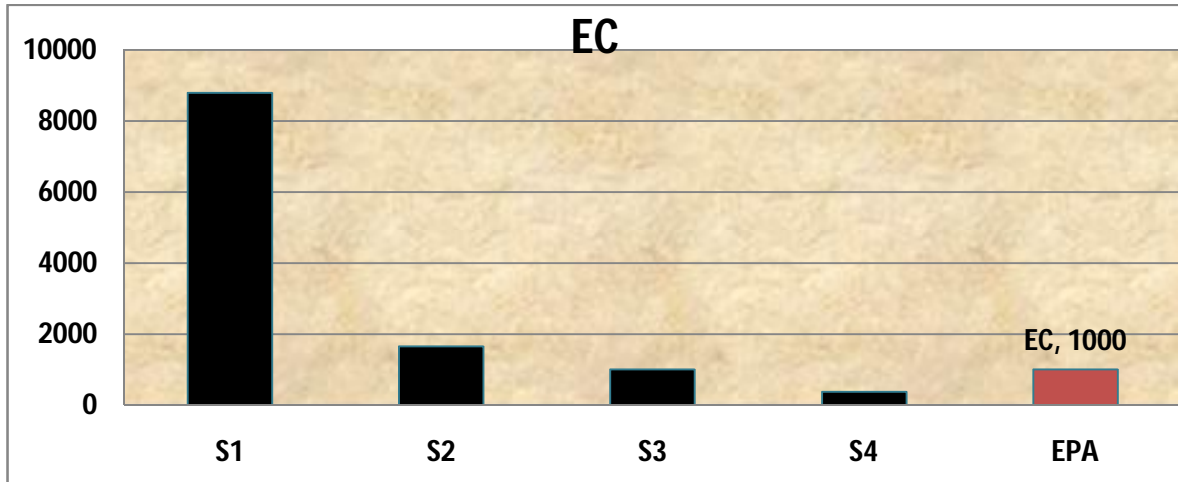


Figure 4-11:EC values with respect to standards at four study sites

4.3.3. Cation Exchange Capacity (CEC)

Soils with high clay and/or organic matter content have high CEC having a high CEC and high buffer. Sandy, low organic matter soils have low CEC. Even though the results are within the standard limit which is (greater than 10meg/100g), it has a decreasing trend towards the impaired sites. This in turn indicates that the organic matter and clay content of the area is declining at the sites closer to the discharge of the effluents.

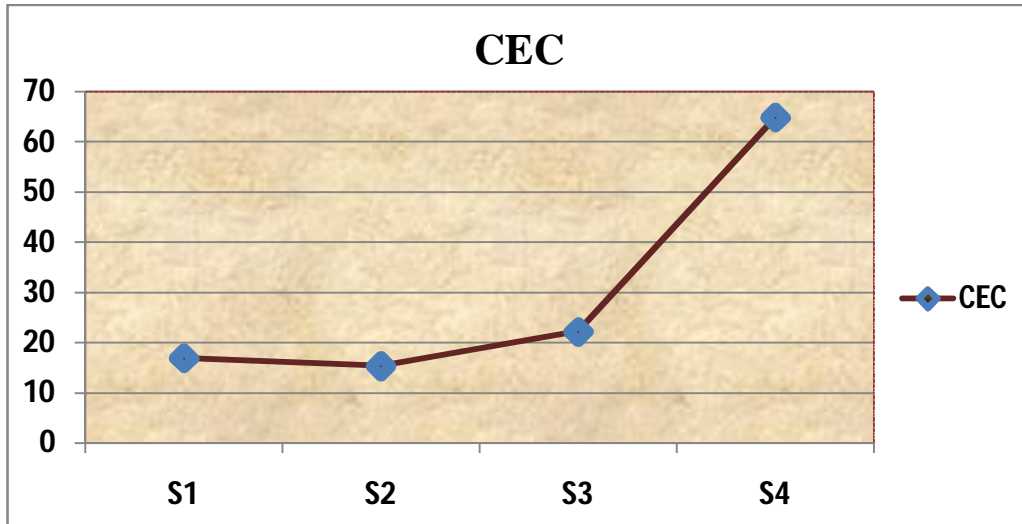


Figure 4-12: The decreasing values of CEC at four study sites of the soil.

4.3.4. Phosphorus-P

The concentration of phosphate in the soils is relatively increased at the impaired sites, it is found to be at high concentration category of FAO guideline values (Table). This could be because of the application of phosphorus containing fertilizers and the effluents drained directly from the flower farm.

Phosphorus applications generally are not recommended when test results are high or excessive. High soil phosphorus combined with P movement from soil into surface waters can cause excessive growth of vegetation, damaging aquatic ecosystems (Lake Ziway)

Table 4-8: Phosphorus (P) soil test categories and suggested fertilizer rate recommendations.

East of Cascades Olsen test P(ppm)	
Low	<10
Medium	10-25
High	25-50
Excessive	>50

4.3.5. Total Nitrogen and Organic carbon

The OC and TN contents decreased at higher volume of effluents (Table 4.5). The extent of OC and TN losses were found to be relatively higher around the sites where the flower farms discharge the effluent directly in to the lake without treating it. It had 0.41, 0.25, 1.19, and 0.04, 0.03, 0.12, respectively; Un treated discharge results in declining in biological activities of a soil due to the side effect of effluents.

The reduction in OC is an indicative for the deterioration of soil quality. According to E.S. Marx et al (1999) a typical agricultural soil contains about 0.10 to 0.15 percent of N. The long-term use of inorganic fertilizers can also be detrimental to the soil because it can kill nitrogen-fixing bacteria and other beneficial organisms. As a result, more fertilizers are applied each year to make up for the loss of natural microorganisms and micro-nutrients (Getu, 2009).

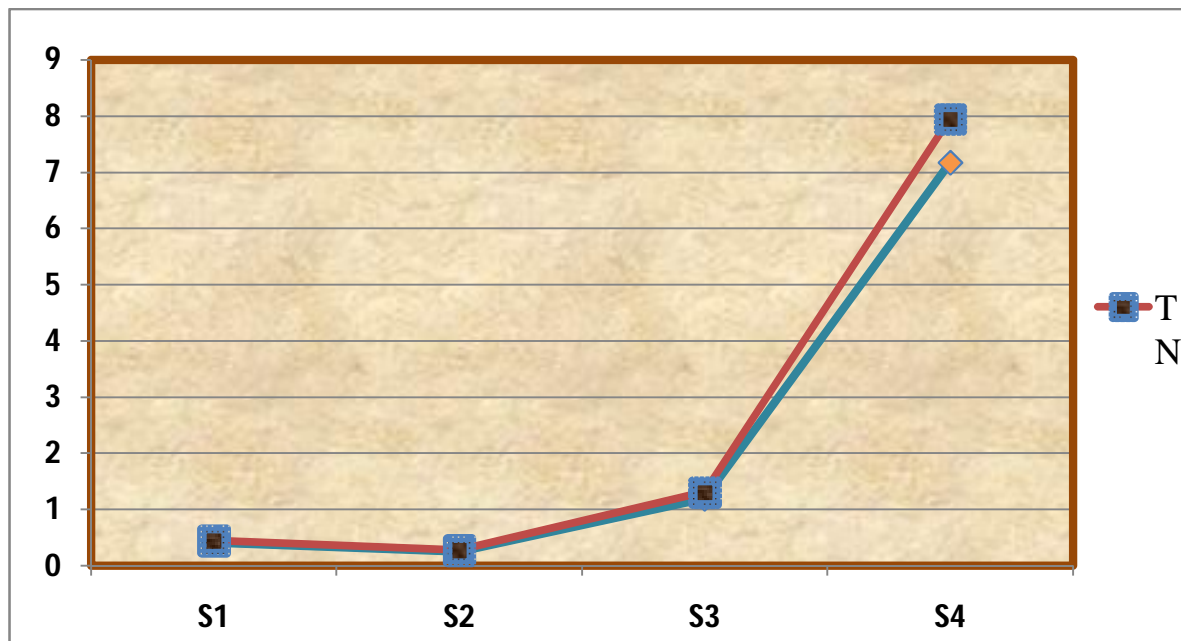


Figure 4-13: concentration of Total Nitrogen & Organic carbon

4.3.6. Exchangeable cation (Mg & Ca) versus Exchangeable cation (Na & K)

In fertile soils, Ca^{++} and Mg^{++} are the dominant basic cations and are in greater concentrations than K^+ . Normally, very little sodium is found in soils, this is true for the controls site as well, however, the values of Na & K increase at SS1, SS2, SS3 and the value of

Mg and Ca has a decreasing trend. The increment of Na & K indicates sodication, (an increase of sodium cations (Na⁺) on the soil particles and the quality of a soil is being degraded.

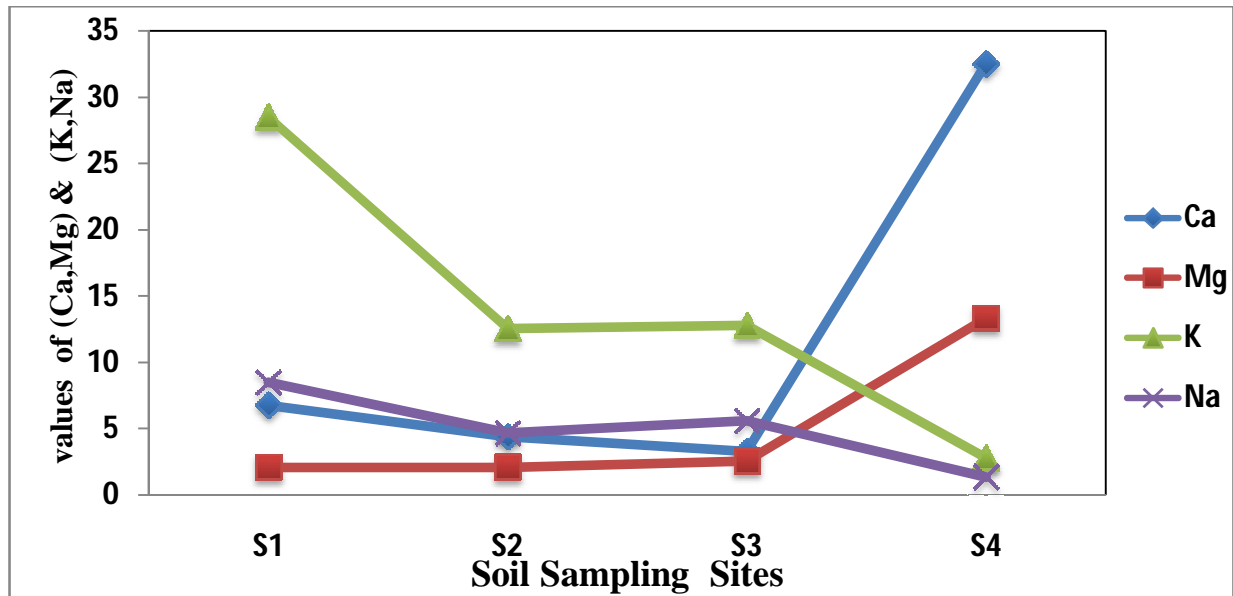


Figure 4-14: values of exchangeable cation (Ca, Mg) & (K, Na)

4.3.7. Soil Quality Degradation

The results obtained from this study showed that most of the soil chemical properties were significantly influenced by floriculture effluent application and untreated discharge. Some of soil chemical properties such as OC contented TN, for instance, showed lower values in the soils close to flower farm. The soil pH, EC, P & exchangeable bases (Na & K) and also increased. Consequently, the neutral or slightly alkaline soils around the farm were changed to saline soil.

Hence the contribution of exchangeable sodium was taken as an additional parameter to verify salinity. According to Sissy Rift Valley Lake areas are one of the potential areas at risk for salinity problem. However, around the riverbank in Ziway horticultural state farm, one is able to see the Solonchack with white salt incrustation on surface (Fisseha 1998) the table below shows the summarized results of the soil samples and the influences on soil quality degradation.

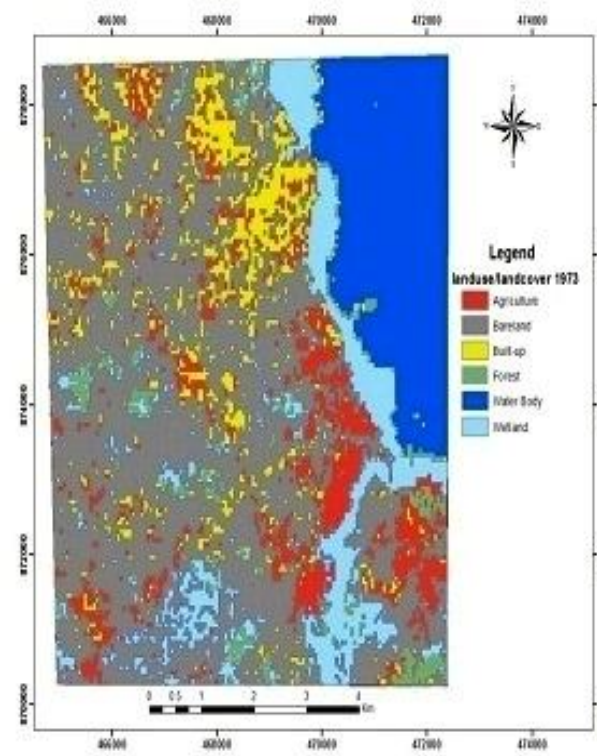
Table 4-9: Extreme values of soil parameters and resultant soil degradation

No	Parameter	Extreme values	Remark
1	PH	10.6	>8.5 indicates sodic soils, poor physical condition and percolation of soil water is slow -root deterioration & OM dissolution
2	EC	8780	>1000 respectively could affect the physico-chemical properties of soil. 800-1600 Affect tolerant plants
3	CEC	16	> 10 meg/100geven though it is within the range, it has a decreasing trend.
4	OC	0.25	<2%
5	P	29	25-50 categorized as high concentration of P in the soil.
6	TN	0.03	A typical agricultural soil contains about 0.10 to 0.15 percent of N. the concentration is very low.

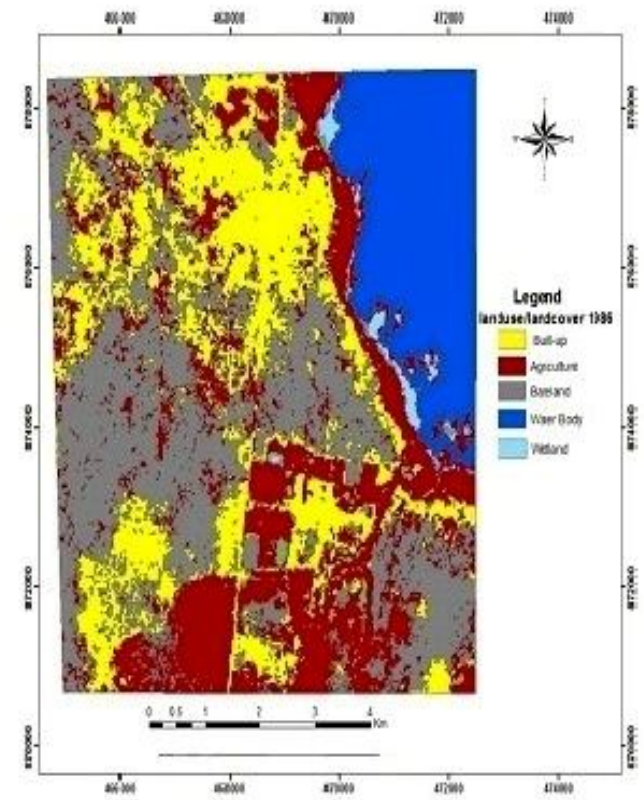
4.4. Land use/Land covers changes

Land use/cover changes from natural forest to different land uses types and the resultant deterioration expected for soil chemical properties are found to be resistant to change on soil with and nature. Obviously, Floriculture industry needs large farm areas this expanded area requirement will lead to land use change and conversion of useful ecological site

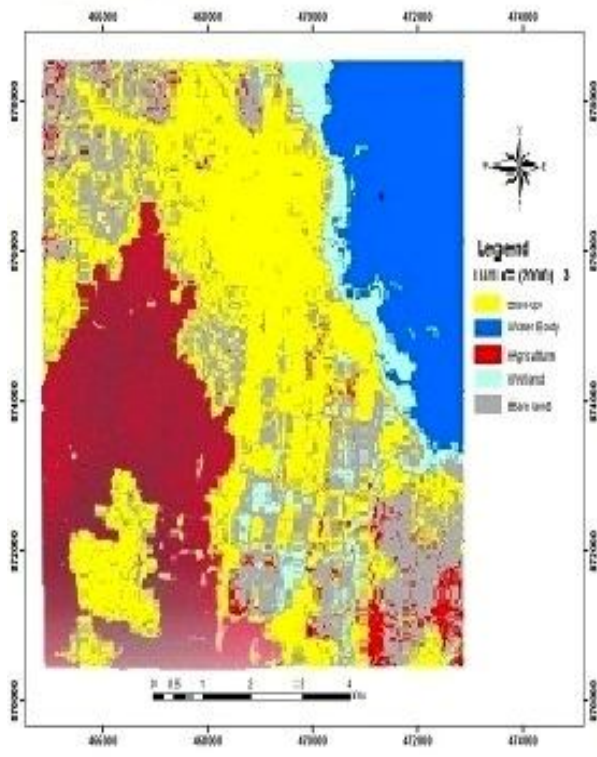
LC/LU 1973



LU/LC 1986



LU/LC2000



LU/LC 2013

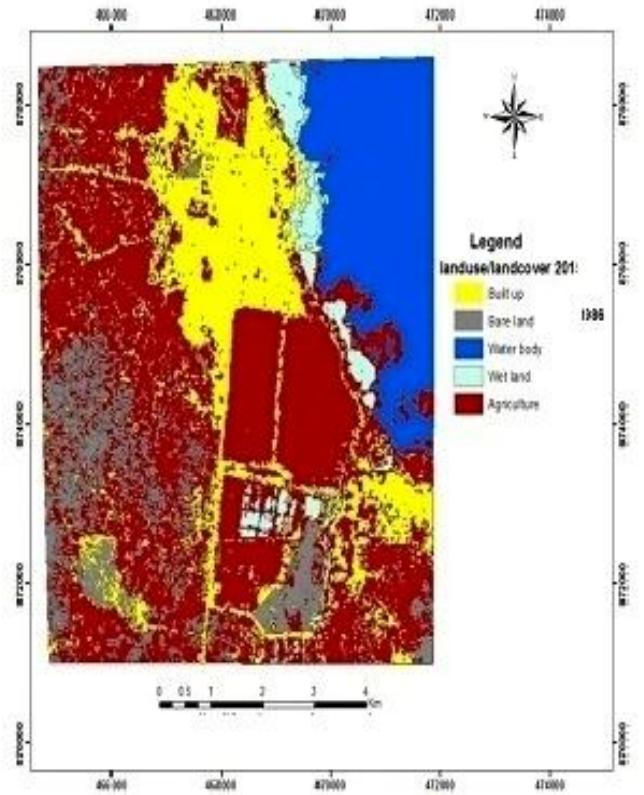


Figure 4-15: Landaus land cover map of the study area at four different time series

In the past 40 years tremendous changes are undergone in the area. The land sat images of 1973, 1986, 2000 and 2013 clearly shows how much the place has changed. The barren land dominance 1973 has been taken up by agricultural and built-up masses. A significant increase in built-up mass and predominantly agricultural areas has taken up the location. Though, no significant lake level decrease noticed. Especially along the lake shore it can be said no space is left unoccupied.



Figure 4-16: shows soil salinity of the area Source (Meron2007)

5. CONCLUSION

The intensive chemicals use by floriculture farms have negative impact on environment, especially changing the soil environment, whereby the discharge without being treated was largely responsible for the contamination. The findings of the study also proved that there were higher values of parameters in the soil adjacent to the floriculture greenhouses, this suggests that the soil has been contaminated, thereby affecting the soil quality. The PH, EC, CEC, P and OC and all the values are found to be higher than permissible levels, area being populated with similar floriculture farms, the basin as a whole is suspected for chemical land degradation.

Water quality adjacent to the floriculture farm

Regarding physicochemical tests:

EC, TDS, Total ammonia, Nitrate (NO₃), Nitrite, Sulphate, (nutrients,) and oxygen demanding parameters have increased. The pH values are slightly lower and have a decreasing trend showing acidification of the water. Especially in sampling sites where waste water management was not put in to practice.

Regarding standards:

parameters analyzed at the impaired sites results were beyond the permissible limits. Based on the guideline values, the potential irrigation problem of the lake water near the farm were slight to moderate; furthermore, it indicates that it is also becoming less suitable for the maintenance of fisheries and aquatic life.

Regarding trends:

the increasing trend of the contamination; signals alarm for immediate action that is during the span of six years time the parameters has more than doubled their values. Although the water quality of Lake Ziway 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.

Soil quality adjacent to the farm

Regarding Soil physicochemical:

parameters EC, PH, TN Exchangeable cation (K&Na) show significant increase at the impaired sites, showing sodication and increased amount of soluble salt in soil

CEC, OC Exchangeable cation(Ca&Mg)show significant decrease at the impaired sites this indicates the decrease infertility, organic matter content, of the soil.

Regrding standard:

All the parameters except CEC are beyond the standard limits.

6. Recommendation

Floriculture industry is huge industry, the waste due to the fertilizer usage changes the quality of water bodies and the soil media also become infertile due to the chemicals spray on it and high amounts of fertilizer solution with acid. Therefore, these all impacts must be studied and emphasized not only as one flower farm impact rather as a sector or floriculture industries impact on environment cumulatively.

- The Ethiopian government should consider requiring EIAs on incoming floriculture companies to more deeply understand the environmental degradation that has happened over the past ten years and to prevent further degradation in the future.
- *Wastewater treatment*; The waste water is incorporated with varieties of chemicals that pollutes water and soil of the surrounding environment .therefore, has to be treated before it is discharged to the nearby lake.
- *Fertilizer management*: providing nutrients in the right quantities at the right time helps to reduce excessive amounts of nutrients entering in to the lake and the surrounding soil.
- *Waste Water recycling*: This method also helps to reduce excessive abstraction of water in addition to protecting the lake water from being polluted.
- conduct research to use natural detoxifications schemes such as Vitivar in large-scale, hence avert degradation
- For the flower and horticulture farms with high fertilizer inputs, they should be aware of the timing, methods of application, because runoff from rainfall that after fertilization with very high N, P content in sediment as well as in runoff water.
- In order to conserve the Zeway freshwater environment without putting off agricultural production, the recommendation is that it is necessary to create or maintain small buffer zones of a forest plantation around the lake shoreline.

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Appendix A.


Soil ph levels and associated condition

Soil PH	Indications	Associated Conditions
<5.5	Soil is deficient in Ca and /or Mg, and should be limed	Poor crop growth due to low cation exchange capacity and possible Al^{3+} toxicity. Expect P deficiency
5.5- 6.5	Soil is lime- free, should be closely monitored	Satisfactory for most crops
6.5- 7.5	Ideal range for crop	Soil cation exchange capacity is production near 100% base saturation.
7.5-8.4	Free lime (Ca Co ₃) exists in soil	Usually excellent filtration and percolation of water due to high Ca content of clays . Both P and micronutrients are less available.
> 8.4	Invariably indicates sodic soil	Poor physical conditions. Infiltration and percolation of soil water is slow. Possible root deterioration and organic matter dissolution.

Appendix B.

Parameters	Sampling Sites			
	S1(control)	S2	S3	S4
Turbidity	94.90	21.9	37.36	41.25
Suspended solids	110	36.00	40	48.
TDS105C(mg/l)	292	1116	694	688
OD	2.95	4.60	5.21	2.77
Electrical conductivity, EC (µs/cm)	507	1874	1009	1007
PH	7.97	7.82	7.90	7.90
Total ammonia	0.57	1.54	0.69	0.76
Nitrate	0.16	0.070	2.107	2.20
Nitrite(mg/l NO3)	3.17	1.09	12.99	12.45
Sulphate (mg/LS	18.13	65.73	74.20	71.15
Reactive phosphate(po4)	0.39	0.09	0.18	0.57
BOD(mg/l)	317.2	291.2	306.8	348.4
COD(mg/l)	700	500	600	900
Total Nitrogen	0.001	0.001	Trace	0.001

Appendix B.

	JIJE Analytical Testing Service Laboratory	Doc. No: JATSL/F5.10-3	Version No.:0
	Analytical Test Report	Page 1 of 1 Effective Date: February 2014	
Customer Name	Tsion Tsegeye	Test Report No	045
Contact Person:	Tsion Tsegeye	Reported date :	21/5/15
Sample Type:	Soil	Test Request No:	Not Specified
Sample Source :	Zeway	Tel:	0920392555
Sample collected by:	Tsion Tsegeye	Fax:	Not Specified
Sample Collected Date:	23/4/2015	E-mail:	anetsion@gmail.com
Sample Received Date:	24/4/2015	Tested by:	LA-06,LA-07 ,LA-08 ,LA-10 &,LA-11
Sample Condition	Normal	Date tested:	13/5/15-19/5/15

S/N	Lab No	Field ID	CEC & Exchangeable Bases (cmol (+)/Kg Soil)				
			CEC	Ca	Mg	Na	K
1	J-S-0698	S1	16.94	6.79	2.09	28.51	8.50
2	J-S-0699	S2	15.37	4.39	2.11	12.75	4.69
3	J-S-0700	S3	22.20	3.30	2.55	12.81	5.61
4	J-S-0701	S4	64.90	32.53	13.34	2.81	1.37

S/N	Lab No	Field ID	EC (dS/m)	pH _{H2O} 1:2.5	Av. P (mg/Kg)	%OC	%TN
1	J-S-0698	S1	8.78	10.53	29.00	0.41	0.04
2	J-S-0699	S2	1.65	10.25	5.49	0.25	0.03
3	J-S-0700	S3	1.01	8.63	26.50	1.19	0.12
4	J-S-0701	S4	0.37	6.48	5.02	7.17	0.78

S/N	Parameter	Test Method
1	Electrical Conductivity (EC)	FAO - Conductivity – Water extract
2	Available Phosphorous (Av. P)	National:1-10.2 Olsen et al.
3	Organic Carbon (OC)	National 1-8: Walkley - Black
4	Total Nitrogen (TN)	National 1-9: Kjeldahl
5	Cation Exchange Capacity (CEC)	FAO - Sodium equivalent by flame photometer
6	Exchangeable Cations (Ca & Mg)	FAO - Ammonium acetate extract - Flame AAS
7	Exchangeable Cations (K & Na)	FAO - Ammonium acetate extract – Flame photometry
8	pH Water	FAO - Potentiometric – Water extract