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Physico-chemical and Macroinvertebrate Assessment of Guji, BiloIlala and Kumbabe Wetlands in Didessa head waters, southwest Ethiopia.

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The thesis **“**Physico-chemical and Macroinvertebrate Assessment of Guji, BiloIlala and Kumbabe Wetlands in Didessa head waters, southwest Ethiopia, has been approved by the Biology Department” for the partial fulfillment of the Degree of Master of Science Biology.

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Abstract

Manyecological studies indicate wetlands are susceptiblefor different ecological challenges. The present study aimed to assess the physicochemical and biological water quality of BiloIlala, Guji and Kumbabewetlands in Didessa headwaters in southwest Ethiopia. In this study the pH, electrical conductivity, water temperature and DO were measured insitu using a multi- meter with different sensor probes while water samples were analyzed for BOD5, TSS and nutrient (nitrate, ammonia and orthophosphate) in the laboratory following standard procedures. Significant variations in the mean values of physico-chemical parameters and nutrients among the three wetland groups were tested using Kruskal-Wallis followed by Mann-Whitney pair wise post-hoc tests due to lack of homoscedasticity and normality in the data. Normality and homoscedasticity of the data were tested using Shapiro-Wilk and Leven statistics respectively. Benferroni p values corrected for multiple testing were used to evaluate significance of pair wise comparisons for the Mann-Whitney post-hoc tests. Spearman's correlation coefficient was used to test the possible correlations among the measured parameters. Macroinvertebrates samples were collected using kick net and preserved in 75% alcohol and identified in laboratory following standard keys. Statistical analyses were run in PAST version 3.08 and SPSS version 16.Acordingly average water temperature of the wetlands varied from 21.4°C to23.5 °C, average dissolved oxygen varied from 6.02 mg/l to 6.79 mg/L, average EC varied from 62 µS/cm to 119.85 µS/cm, pH values varied from 6.99 to 7.31, TSS values for the wetland varied from 0.004 mg/L to 0.007 mg/L. Whereas the median values of NH_3, NO_3^- *and* PO_4^{3-} *varied from 0.06 mg/L to 0.14 mg/L, 0.67 mg/L to 3.09 mg/L and 0.45 mg/L 0.81 respectively. Similarly MMI scores for all the wetlands showed very good wetland condition. Habitat assessment also implies that grazing has the highest impact.*

Key word: BOD, dissolved oxygen, physicochemical, spectrophotometer

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1. Background

1.1. Introduction

According to Ramsar (1971), Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. Wetlands provide many ecological, hydrological and Socio-economic functions (Dixon, 2003). According to theworld Conservation Monitoring Centre(1995), wetlands are source of rivers, storm water control, control water flow and acts as waste purification systems. Wetlands also serve as retention sink of nutrients from the catchment area, toxic waste and sediments (Enger and Smith, 2000). Wetlands are found on every continent except Antarctica and in almost all climatic zones on these continents (Mitsch and Gosselink, 2000).

According to Donal (1993), wetlands are estimated to about 3 to 6% of the world's land area**.** Finlayson and Vander (1995**)** also estimated that about 5% of the land surface of the earth is covered with wetlands. The distribution of these wetlands is uneven with major wetlands areas in the arctic and subarctic regions of North America, Europe, and Asia (Charman, 2002). Wetlands are also found in association with large tropical rivers and lakes in South America and Africa (Charman, 2002).

More than 50 % of the area of certain wetland types had been lostduring the 20th century in parts of Australia, New Zealand, Europe and North America (Millennium Ecosystem Assessment, 2005). Causes of the decline in freshwater biodiversity are numerous, but the principal and most widespread threats are habitat degradation, pollution, flow regulation and water extraction, fisheries overexploitation, and alien species introductions, all of which are or will be compounded by climate change (Strayer and Dudgeon 2010).According to Junk *et al.* (2013), the amount of loss of wetlands around the world varies between 30 and 90%. Global inland and coastal wetlands cover over 12.1 million km^2, an area almost as large as Greenland, with 54% permanently inundated and 46% seasonally inundated. However, natural wetlands coverage declined around the world; between 1970 and 2015, inland and marine/coastal wetlands both declined by approximately 35%, where data are available, three times the rate of forest loss. In contrast, human-made wetlands, largely rice paddy and reservoirs, almost doubled over this period, now forming 12% of wetlands. These increases have not compensated for natural wetland loss.

Africa is best known for its different sized savannahs and hot deserts. Only 1% of its surface area (345,000 km2) is covered by wetlands (Finlayson and Moser, 1991). As reports of different people and organizations depicts, African wetlands are now days facing great ecological threats. Some of these are population growth (World fact Book, 2011), mining (Harrison *et al*.,(2010), alien invasive biota Shanungu, (2009) and Climate change Hulme*et al*.,(2005).

Hailu(2005) estimated the coverage of wetland in Ethiopia as they cover around 2% of the total of the country land coverage. With the exception of coastal and marine-related wetlands and extensive swamp-forest complexes, all forms of wetlands are there in Ethiopia. These include alpine formations, riverine, lacustrine, palustrine and floodplain wetlands (Abebe and Geheb, 2003).The extent of wetlands and their species diversity has declined over the past years (Turner, 1990).

According to Dixon (2003) and Okurut(2000),this species decline were reported due to population pressure, increased inflow of nutrients, encroachment for agricultural activities and new areas for development. According toHollis (1990), species reduction in wetland ecosystem was also been driven by public misperception of the benefits of wetlands. This is mainly done in the temperate climate where the practice of discharging waste water into natural wetlands has been used as waste depository for hundreds of years (Edlowhey et al., 1993).

1.2. Statement of the problem

Water quality is a key concern for human wellbeing and yet trends are mostly negative (Horwitz et al. 2012). According to Russi et al. (2013) declining water quality degrades wetlands, although conversely wetlands also improve water quality through ecosystem regulating services.In Ethiopia; many ecological researches have been conducted. Perhaps almost most of these studies are being done with the concern of terrestrial ecosystems. Only few of them are done on wetland issues. As a result, even though many of Ethiopian wetlands are facing a great ecological challenge, even up to extinction, there is no much research based information about their conditions. Therefore this study was done to assess the conditions of three selected (Guji, BiloIlala and Kumbabe) Wetlands in Chora district in southwestern Ethiopia.

According to Finlayson and Vander (1995)many developing countries have no clear ecological policies for sustainable use of wetlands. The statuses and conditions of many wetlands are not known (Balance, 1996). As a result of this many of these ecosystems are losing necessary protection. Due to this many wetlands and biodiversity living in them are facing versatile ecological challenges(Finlayson and Vander, 1995).Nowa day BiloIlala, Guji and Kumbabe wetlands are beingserving the local community in many ways. Ecologically these wetlands are retaining different nutrients and chemicals carried by erosion from uplands. Therefore the present study has assessed the overall status of these wetlands by quantifying different physicochemical parameters and comparing the results with composition of different macro invertebrates. Such information is necessary for the efficient planning of long term sustainable use of these wetlands. Generally, the overall data in the present study were organized by using physicochemical, macro invertebrate parameter and average habitat disturbance score.

1.3. Objectives of the study

1.3.1. General objective

The study aimed to assess the physicochemical and biological water quality of BiloIlala, Guji and Kumbabe wetlands in Didessa headwaters, southwest Ethiopia.

1.3.2. Specific objectives

- To determinephysico-chemical parameters (water temperature [Water T°], dissolved oxygen [DO], total suspended solids (TSS),pH, electric conductivity [EC],BOD_5 and nutrient (nitrogen and phosphorus) level of BiloIlalaGuji and Kumbabe wetlands.
- To identify and quantify the macroinvertebrate assemblage of the wetlands
- To assess the associated physical habitat characteristics of the wetlands

1.4. Significance of the study

Now days one of the greatest challenges in our planet is the ecological challenges. Some of these are resulted from human action (Smith,1995). Since they are found in very determinant location, wetlands filter a lot of wastes loaded to them in many ways (Ramsar, 2009). Therefore they are doing the same function as like that of the kidney of one living organism.

As a report of many ecological researches (Turner,(1990);Okurut,(2000) and Dixon (2003)) wetlands and biodiversity living in them are facing great ecological stresses.

The present study has assessed that the statuses of three natural wetlands found in ChoraKumbabe district, in Didessa head waters.The finding of the present study enhances the attitude of local society and governmental organizations toward the conservation and sustainable uses of wetlands. Similarly it is helpful to design different ecological policies to enhance the sustainable uses of wetlands too. Generally this study is very helpful reduce ecological challenges in these three wetlands and reduces the rate at which both the wetlands and biodiversity in them lose.

2. Literature review

2.1. Wetland definition

Several attempts have been made by national and international organizations to develop a formal definition of wetlands (Finlayson and Vander, 1995). A wetland is a land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem (Ramsar, 1971). According to Wetland International (2003), wetlands are lands where water collects on the land surface long enough to promote soil development and support the types of plant and animal communities adapted to saturated conditions. Valk (2006) has defined wetlands as area with shallow water or saturated soils whose vegetation is dominated by species of large plants that are found nowhere else in the surrounding uplands.

2.2. Wetland and human history

Wetlands have been intricately linked with humankind throughout the ages. Throughout history humans have gathered around wetlands and these areas have played an important part in human development and are of significant religious, historical or archeological value to many cultures around the world (Maltby, 1991). Wetlands play a noticeable role in the growth of human civilizations and cultural development. This is true globally, where major prehistoric civilizations, including those on the Nile, Euphrates and Tigris, have emerged and developed (Finlayson and Moser, 1991). Evidence of rice culture linked with human dates to the earliest age of humans, long before the era of historical records. About 40% of the world's population uses rice as a major staple rice culture currently occupies about 15% of the world's wetland area (Tiner, 1999).

2.3. Wetlands as biological filters

Wetlands are valued for high biological productivity as filters, sinks, and transformers for sediments, nutrients, pollutants and as buffers between aquatic systems and human activities on upland areas. Because of their varied ecological functions, wetlands are of interest to Eco toxicologists as potential sites for detoxifying pollutants. As an ecosystem process, water regulation provides for final ecosystem services such as storm protection, improving water quality and extending water provision as a time delay that is providing a regulated hydrologic flow (Turner et al., 2008).

The roots of wetland plants bind the shoreline together, resisting erosion by wind and waves and providing a physical barrier that slows down storm surges and tidal waves, thereby reducing their height and destructive power (USEPA,1998). We can conceive of valuing wetlands as essentially valuing the benefit characteristics of the system and can capture these values in an economic value framework. Wetlands are noted for their services like, nutrient cycling, water regulation, food web support, clean water provision, ecosystem maintenance, drinking water supply, flood protection, fish, forest products, on-timber forest products(Turner et al.,2008).

2.4. Hydrological services of wetlands

Hydrological services refer to the wetland's ability to store flood waters, the interactions between ground and surface waters and the storage of sediments. Wetlands also play an important role in the hydrologic cycle we all experience quite readily, for example with the precipitation from a thunderstorm and the evaporation of pond water from a puddle or bird bath. Wetlands can receive store and release water in various ways, physically through ground water and surface water, as well as biologically through transpiration by vegetation and therefore function in this very important global cycle. These complex habitats act as giant sponges, soaking up rainfall and slowly releasing it over time (USEPA,1998).

Sediment retention is the net retention of sediments carried in suspension by waters inundating the wetland from river overbank flooding and run off from a contributory area. Flood water retention, the short and long term retention and storage of waters from overbank flooding and slope run off. Groundwater discharge is the upward seepage of groundwater to the wetland surface. According to Roggeri (1995), wetland's functions comprise those natural processes that sustain economic activities and fortify ecological integrity.

Besides water being the most basic product that a wetland can provide, food, fuel wood, wildlife, fisheries, forage and agricultural resources are additional wetland products. Wetland attributes are closely intermeshed with the ethical and aesthetic values that human beings attach to them (Roggeri, 1995).Rice is the staple diet of nearly 3 billion people half the world's population. It is grown in wetlands across Asia and West Africa and in the United States.

Ecological Studies (2002) have discussed as chemical nature and concentration of various substances dissolved in the water determine its pH, hardness, salinity, nutrient content and other measures used to categorize water chemistry and can have a significant impact on the flora and fauna of the wetlands (Steward and Kantrud, 1972). Only2.6% of the world's water is fresh (Illueca and Rast, 1996). Only a fraction of the world's fresh water is available for consumption because so much of it is locked up in polar icecaps and glaciers (Illueca and Rast,1996).Africa uses only 4% of its renewable freshwater resources because of the uneven distribution of water resources over the continent (UNEP,2000). These regional patterns are also evident in Ethiopia, where water resources are unevenly distributed and only a quarter of its population has access to safe water and sanitation.

2.5. Wetlands in water quality issue

As Sim,(2003) wetlands, be it constructed or natural, offer a cheaper and low cost alternative technology, for wastewater treatment. The treatment efficiency of a wetland system requires a balance between pollutant loading rate and hydraulic retention time, which is also affected by the water quality and quantity of wastewater effluent or storm water runoff (Greenway, 2004). The ability of wetlands to improve the quality of water has long been recognized and this had led to proliferation of wetlands as a means to treat diffuse and point source pollutants from a range of land uses (Brian, 2008).

This is mainly done in the temperate climate with paucity of information on the effectiveness of wetlands particularly natural wetlands in tropical regions, where the practice of discharging waste water into natural wetlands has been used as waste depository for hundreds of years (Edlowhey*et al*., 1993).Brix (2005), refers to wetlands as the kidneys of the landscape and strongly believes that a constructed wetland is a tool that can be used to improve water quality. These systems were mainly use to filter runoff from acid mines, storm water, industrial activities, agriculture and municipal wastewater (Jing, 2001).

The most significant functions of wetland plants, in relation to water purification are the physical effects brought by the presence of the plants. Algae are involved in the improvement of air and water quality through their photosynthetic activity and uptake of undesirable nutrients (Elizabeth and Willen, 1996). A range of wetland plants has shown their ability to assist in the breakdown of wastewater. Hollow vessels in the plant tissues enable oxygen to be transported from the leaves to the root zone and to the surrounding soil (Brix and

Schierup, 2005). This enables the active microbial aerobic decomposition process and the uptakes of pollutants from the water system to take place (Armstrong et al., 1990; Brix and Schierup, 2005).

Wetlands are valuable to us because they greatly influence the flow and quality of water. Treating wastewater is a vital resource for ensuring the health and safety of residents and the environment (Bartram and Balance, 1996). It is widely recognized that the limited availability of clean freshwater will increasingly become a matter of controversy between local communities in many semiarid regions of the world. Wetland functioning in a changing world is dependent on water as other sectors Riparian wetlands bordering lower order streams and floodplains of mid-size and larger rivers have a great potential to remove nutrients and pollutants from through flowing water (UNEP, 2000). According to Sima et al. (2009), this method is simple and requires less power and financial means. Increasing attention is now also being paid to using constructed wetlands to treat leakage, contaminated groundwater and industrial effluents.

According to the agency of Sim,(2003), nowadays constructed wetlands are being used in many countries for waste water treatments. Constructed wetlands are designed to take advantage of many of the same processes that occur in natural wetlands, but do so within a more controlled environment (Sima and Holcova, 2011).Constructed wetlands are engineered systems that have been designed and constructed to utilize the natural processes involving wetland vegetation soils, and the associated microbial assemblages to assist in treating wastewaters (Vymazal, 2005).

The growing usage of constructed wetland systems are mainly utilized to manage domestic wastewater, agricultural wastewater and mine drainage water are treated in constructed wetlands (Knight*et al*.,2000).Constructed wetlands would be able to combat the removal of suspended solids, biodegradable organic matter as well as nitrogen and phosphorus (Brix et al.,2000). The role of wetlands in water treatment is also being increasingly appreciated, even for such potent problems as human sewage (Romanowski,2009).Treating wastewater in semi natural plant systems is a technique which can in principle be applied in natural wetlands such as marshes, moors and wet fields, in artificial ponds and lagoons, and in specially constructed wetlands (Kadlec and Knight 1996).

Both systems focus their filtration around eliminating four specific variables: suspended solids, organic matter, phosphorus and nitrogen (Jing,2001). Organic compounds are degraded aerobically as well as aerobically in constructed wetlands. Oxygen required for aerobic degradation is supplied directly from the atmosphere by diffusion or oxygen leakage from the saprophyte roots into the rhizosphere (Sima*et al*.,2008).

As Greenway (2004) stated microorganisms are the most abundant and diverse group of living organisms in wetland systems. They include autotrophic and heterotrophic bacteria, fungi, unicellular and filamentous algae and protozoan. Microorganisms occur in the water column or to surfaces as bio films. Anaerobic bacteria occur in low oxygen environments in the sediment. Microbial processes of significance to the removal and transformation of nitrogen are ammonification, nitrification and denitrification. Ammonificationof dead organic matter occurs under both aerobic and anaerobic conditions. Ammonium ions can either be assimilated by plants and algae or nitrified under aerobic conditions by nitrifying bacteria to nitrites and nitrates. Pretreatment and detention times are crucial parameters to maximize pollutant removal efficiency (Brian, 2008).

2.6. Wetlands and their other ecological values

Wetlands have direct values that include both production and consumption goods. These are the raw materials and physical products that are used directly for production, consumption and sale including those providing energy, shelter, food, agricultural production, water supply, transportation and recreation. (Sisay, 2003).The indirect uses of wetlands are their hydrological and ecological functions, which support various economic activities, life support systems and human welfare. This includes ground water recharge, flood control, nutrient cycling, erosion control and sediment traps, climate regulation, habitats for migratory wildlife and pest control Wetlands yield fuel wood for cooking, roofing, paper making and timber for building. Medicines are extracted from their bark, leaves and fruits (Dugan, 1990).

According to Sisay (2003), invertebrates in wetlands are important biological control agents of some disease vectors. For example Copepod mesocyclops, is an effective predator of malaria causing mosquitoes. Certain aquatic beetles clean the alien invasive aquatic weed, water hyacinth (Eichhorniacrassipes).In addition to this wetland invertebrates also have educational, scientific and biotechnological values because they are good models with which to understand biological systems and are used in sewage treatment plants, fermentation processes and in the production of useful biomolecules.

Because of their position on the landscape, wetlands at the margins of lakes, rivers, bays and the ocean help protect shorelines and stream banks against erosion (Fraser and Keddy,2005).The devastating effects of natural phenomena such as hurricanes, cyclones and tsunamis cannot be denied. Worldwide, an estimated 200 million people who live in low lying coastal regions are at potential risk from catastrophic flooding. Coastal wetlands such as reefs, mangroves and salt marshes act as frontline defenses against potential devastation. The most significant social and economic benefit that wetlands provide is flood control. Peat lands and wet grasslands alongside river basins can act like sponges, absorbing rainfall and controlling its flow in to stream sand rivers (Stewart and Kantrud, 1972).

Biogeochemical services of a wetland refer to the export and storage of naturally occurring chemical compounds that can have significant effects on the quality of the environment. Similarly nutrient retention is the storage of excess nutrients (nitrogen and phosphorus) via biological, biochemical and geochemical processes in biomass (living and dead) and soil mineral compounds of a wetland (Elizabeth and Willen, 1996). Nutrient export is a basic process that is used in removal of excess nutrients like nitrogen and phosphorus from a wetland via biological, biochemical, physical and land management processes.

In-situ carbon retention is the retention of carbon in the form of partially decomposed organic matter or peat in the soil profile due to environmental conditions that reduce rates of decomposition. Trace element storage and export refers that the storage and removal of trace elements from the wetland. Ecosystem maintenance the provision of habitat for animals and plants through the interaction of physical, chemical and biological wetland processes (including habitat and biological diversity).Nursery for plants, animals, microorganisms (Maltby,1986). Ecological services relate primarily to the maintenance of habitats within which organisms live. Wetlands also support of food webs within and outside a wetland through the production of biomass and its subsequent accumulation and export (Sather et al, 1990).

Wetlands provide many recreational, educational and research opportunities. Nature related recreation is the fastest growing activity of the tourism industry with an annual increase of about 30% since 1987.Much of this nature based tourism involves birds, many of which are wetland dependent (USEPA, 1998). Given the multifaceted nature of benefits associated with wetlands there is a need for a useable typology of the associated social, economic and cultural values. These values depend on human preferences that are what people perceive as the impact wetlands have on their welfare (Ellis, *et al*, 2003).

2.7. Threats to wetlands sustainability

Wetlands and their value are little understood and their loss is increasingly becoming an environmental disaster (Yilma, 2003).According to Verhoeven*et al*.,(2002) Wetland ecosystems are a natural resource of global significance. Also Yilma (2003), wetlands are the most productive of ecosystems on earth; they are also the most threatened. This is mainly pertinent in arid and semi-arid areas where the majority of wetlands are temporary (Ramsar, 2011).The most threats to wetlands are simply termed as HIPO (Habitat distraction, Introduction of invasive species, Pollution and over exploitation.

Historically, their high level of plant and animal (especially bird) diversity is perhaps the major reason why wetland protection has become a high priority worldwide supported by international agreements such as the Ramsar Convention and the International Convention of biological biodiversity (Fraser and Keddy, 2005). Large percentage of wetlands have been lost in the last century and that ongoing degradation and loss is occurring worldwide (Williams, 1999).Biodiversity loss occurs in wetland systems through land use changes, habitat destruction, pollution, exploitation of resources, and invasive species (Mitsch and Gosselink, 2000).

Perhaps the most destructive of all activities is mining which permanently destroys the substrate and prevents the natural restoration of site (Williams, 1990) .Wetland destruction and alteration has been and is still seen as an advanced mode of development, even at the government level (Maltby,1991). Wetland loss is evident wherever major developments like dams, irrigation schemes and conversion projects are present in the developing world (Dugan, 1990). While most of the threats that wetlands face result from their miss use, many are also related to unsustainable resource extraction. Another important reason for their vulnerability is the fact that they are dynamic systems undergoing continual change (Barbier*et al*.,1996).

As long as the world's population continues to grow at exponential rates, it seems highly probable that pressure to use wetlands to meet society's demands will increase (Loffler, 1990).The role that wetlands play in maintaining quality of life will depend more and more on our collective ability to develop and promote compatible uses on wetlands Sather, *et al.(*1990). These require the wise use of every resource in wetland. The wise use of wetlands is a complex concept to implement and requires the support of national programs addressing several factors including information, policy, research, awareness, management and institution building (Dugan, 1990).

In recent time different reports are showing irrigation is using a massive of groundwater. About 80% of the world's groundwater used for agricultural production. Unsustainable abstraction of groundwater has become a major concern of wetland lose (Ramsar,2011).Threats to rice fields mainly stem from inappropriate water management, introduction of invasive alien species, agricultural fertilizers, pesticides, and land use changes(Maltby,1991). People who live and work near the coast are expected to grow immensely over the next fifty years (Maltby, 1986). From an estimate, 200 million people are currently live in low lying coastal regions, the development of urban coastal centers is projected to increase the population by fivefold within 50 years United Nations Environment Program.

3. Materials and Methods

3.1. Description of Study area and Sampling sites

This study was carried out in BiloIlala, Guji and Kumbabe wetlands in ChoraKumbabe district. Three wetlands namely Guji, BiloIlala and Kumbabe all located in Didessa River headwaters (Blue Nile sub-catchment) in Chora District, Buno-Bedele Zone, and southwest Ethiopia were studied. Guji wetland has three tails with three small streams and it was sampled at seven sites: two sites around Didu River, two sites around Ficho River and three sites around Doyu River. BiloIlala wetland was sampled at four sites and Kumbabe wetland was sampled at five sites (Table 1; Fig. 1).

Geographically these wetlands are found at different positions. Guji wetland is found at (822°.924'N-823°.494'N to 367°.354'E-367°.841'E).Bilo wetland is also found at (824°.033'N-824°.479'N to 366°.486'E-367°.244'E) whereas Kumbabe wetland is situated (822°.195'N-823°.001'N to 3610°.182E-3610°.801E) .The District belongs to the Eastern Afromontane Biodiversity Hotspot (Mittermeier*et al*., 2004). The district is surrounded by Bedele, Dega, Gechi, Setema, SupenaSodo and Yayu districts (Figure 1). The district is characterized by eight months of rainfall with annual ranging from 1500 to 2200mm. The temperature varies between 9°C- 31°C.All sampling sites in Guji, Bilo and Kumbabe wetland are found at altitude of 1907-1921m, 1908-1933m and1839- 1857m respectively.

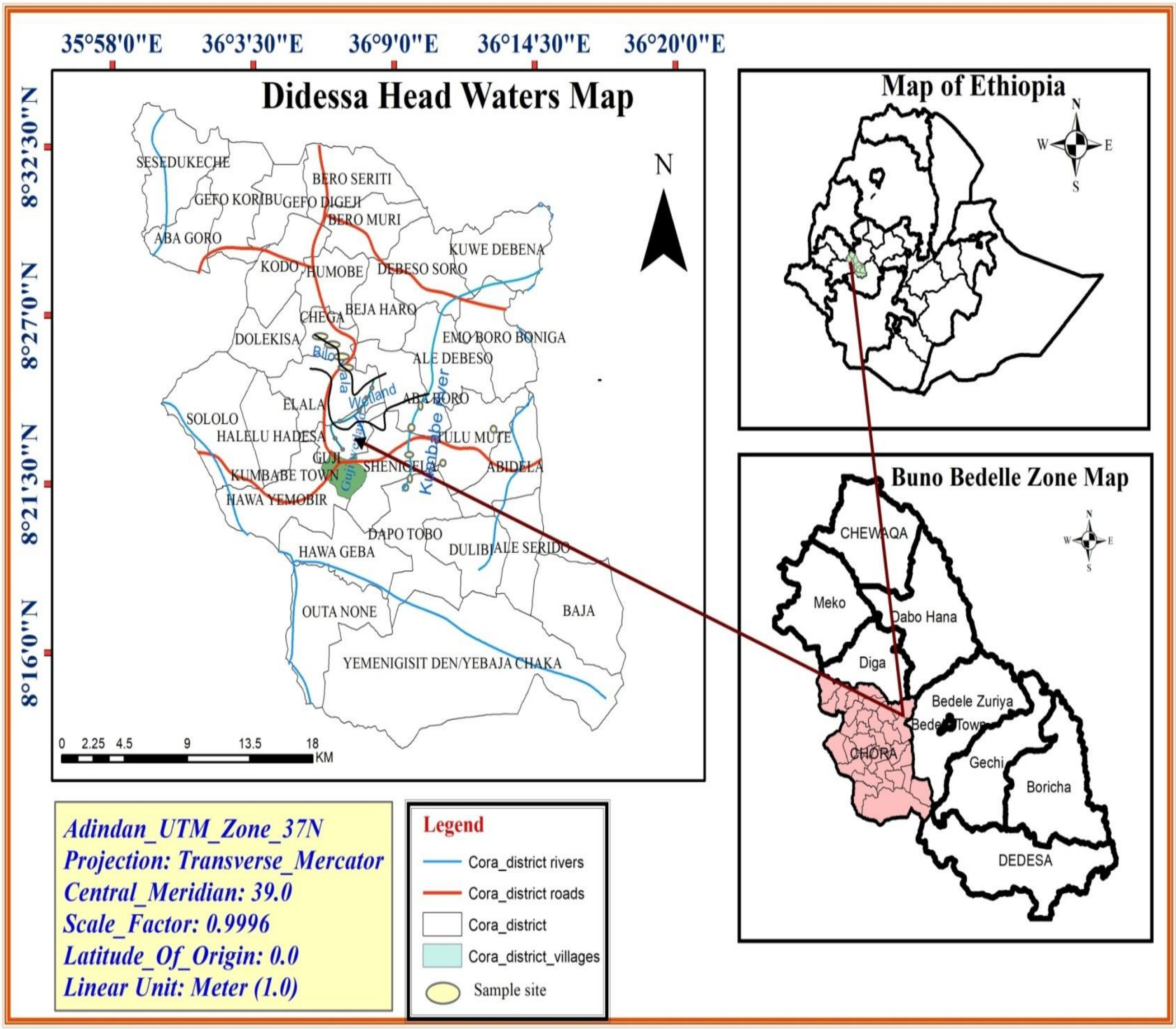

Fig.1 Map of the study area and sampling sites

Table 1.Sampling sites of the study wetlands

Wetland and site	Alt (m)	N (° ')	E (° ')	Site	Alt (m)	N (° ')	E (° ')
Guji1 (Didu River)	1920	8 22.934	36 7.376	Bilo Ilala2	1926	8 24.413	36 6.663
Guji2 (Didu River)	1921	8 23.052	36 7.354	Bilo Ilala3	1917	8 24.322	36 6.793
Guji3(Ficho River)	1915	8 23.494	36 7.625	Bilo Ilala4	1908	8 24.033	36 7.244
Guji4(Ficho River)	1912	8 23.552	36 7.673	Kumbabe1	1850	8 22.195	3610.801
Guji5(Doyu River)	1914	8 23.141	36 7.614	Kumbabe2	1862	8 22.328	3610.642
Guji6 (Doyu River)	1917	8 23.194	36 7.708	Kumbabe3	1839	8 22.418	3610.579
Guji7 (DoyuRiver)	1907	8 23.124	36 7.841	Kumbabe4	1854	8 22.623	3610.465
Bilo Ilala1	1933	8 24.479	36 6.486	Kumbabe5	1857	8 23.001	3610.182

3.2. Field work

Water sample and macro-invertebrate were collected in one wet season in November and one dry season from in March. Each wetland was sampled ones during each season. In each of the three wetlands different sample sites was assigned based on the nature and size of the wetlands. In each BiloIlala, Guji and Kumbabe wetlands four, seven and five sampling sites were selected respectively. The overall area covered under this study was estimated to be above 150hectars (30hectars in Bilo, 36 hectares and 84 hectares).

Water quality analysis is important to protect the natural ecosystem. For that reason, somephysico chemical parameters were assessed in the present study on field and in laboratory.

Physicochemical parameters that weremeasured *in situ* were water temperature, DO, pH and electric conductivity (EC). Temperature is one of the principal physical factors of great importance for aquatic ecosystem. Temperature has overall effects on organisms as well as on physico-chemical characteristics of water. Water temperature was measured by taking water sample of about two litres and immersing the malty meter probe into it for a sufficient period of time. As the reading was stabilized, the reading was taken and expressed as °C. About 2liters of the sample water was taken in a wide mouth plastic container and multi meter probe was immersed into it and the pH meter reading was taken and recorded. Like the other physicochemical parameters like water temperature and pH, DO and EC were also measured using multi-meter and suitable sensor probes and the result were expressed by mg/L and µS/cm respectively.

From each sampling site two litters of sample water was taken using gently washed 2L containing plastic bottles for later analysis of nitrate(NO_3), ammonia(NH_3)and orthophosphate. All taken samples from each sampling site were preserved under suitable condition at 4 degree °C using ice box from field to laboratory. Until the samples were assessed for the other physicochemical parameters, the water samples were kept under deep freeze.

Fig.2. Water sample for analysis different physicochemical parameters

Accordingly, five different physico chemicals parameters, total suspended solid (TSS), nutrients (nitrate, ammonia, orthophosphate) load and biological oxygen demand(BOD_5)in each sampling sites were analyzed in laboratory following the standard procedures for each parameter. The parameters were analyzed from water sample taken from all sampling sites in each wetland during both sampling seasons (wet and dry).

Macro-invertebrates samples were collected using rectangular kick net of 20×30cm with a mesh size of 300µm at each every sampling site. The sampling was realized through a

10minute kick-sampling over a distance of 10 m. The sampled macro-invertebrate were collected in falcon tube and preserved in 70% ethanol as appropriate for further analysis in the laboratory (Mereta*et al*.,2013).The overall of both on field measured and lab analyzed physicochemical parameters and macro invertebrates in wet season are summarized and presented in Appendix 2 and Appendix 3.

Preliminary habitat characteristics for each wetland were assessed using disturbance scoring methods slightly modified from Mereta*et al*. (2013) in a way that only parameters that are more relevant for the studied wetlands were maintained (Appendix 1). Five disturbance factors related to habitat alteration (grazing, vegetation removal and tree plantation), land use (farming) and hydrological modification (draining and ditching) were used to assess the status of the wetlands.

3.3. Sample Analysis

All physicochemical parameters tested from the water sample brought to laboratory were analysed following (APHA,1999).TSS was analysed using filtration technique. Water sample for TSS assessment was filtered following filtration procedure. First filter paper was dried at 103^{o} C in oven for an hour. Then the dried filter paper was kept in desiccators to cool. Finally the filter paper was weighed and the mass was registered as initial mass. Later known volume of the well-mixed sample water (50ml) was measured and filtered using sanction machine and the pre weighed filter paper. As filtration was finished, filter paper was removed from the sanction machine and dried in an oven for the second time for about an hour at 103-105^{o} C and cooled in desiccators. Again the filter paper with the suspension was weighed for constant weight. Lastly TSS was taken as mass difference of constant weight and initial mass of the filter paper. The obtained TSS mass was corrected by calculation to per litre.

Similarly physicochemical parameters analyzed in laboratory were analyzed using different standard experimental methods. Phenoldisulfonic acid method was used for nitrate test. Since phenoldisulfonic acid method was used to test nitrate, phenoldisulfonic acid reagent was prepared by dissolving 12.5g pure white phenol in 75 mL conc.H_2SO_4.Then 37.5 mL of fuming H_2SO_4 was added via string. Next to that the mixture was heat for 2 hour on a hot plate.On the other hand 12N KOH solution was also prepare by dissolving 336.5g KOH in distilled water and diluting to 500 ml. Similarly, stock nitrate solution was also prepared by dissolving 4.86g anhydrous potassium nitrate in distilled water and then dilute to 500 mL with further addition of distilled water 1 mL = 100 µg N.

Standard nitrate solution was also prepared by evaporating 25.ml stock nitrate solution to dryness on hot plate and the residue was dissolved the by rubbing with 2ml of phenoldisulfonic acid reagent and dilute to 250ml with distilled water 1ml= 10µg N= 44.3 µg NO_3. The diluted residue solution was again treaded by 7ml of 12N KOH and Series of nitrate standards of solution was again prepared by transferring 0.00, 0.04, 0.100, 0.6, 1 and 2ml of standard ammonium chloride solution with concentration of 0.00, 0.048, 0.348, 0.449and0.934nitrate-nitrogen µg/L to a 50mL volumetric flask stoppered graduated cylinder to plot calibration curve.

Finally the absorbance was read at 410 nm within10 minutes and calibration curve was plotted on the basis the following of concentration versus absorbance. Sincephenoldisulfonic acid method was used for nitrate test, 25ml of filtrated sample water was evaporated on the hot plate. The obtained residue was then dissolved in 2ml of phenol disulfonic acid through continuous rubbing and diluted to 50ml distilled water.

Fig. 3. Sample water evaporation for nitrate test

Once the dilution was accomplished, 7ml concentrated solution of (12NKOH) potassium hydroxide was added to settle the suspensions and the mixture was developed yellowish colour. As the colour was developed, absorbance was read at 410nm using a spectrophotometer (DR5000) with in10-12 minutes. The absorbance value was taken on the bases of standard calibration curve plotted using standard nitrogen solution using distilled water as blank (0.00). The standard calibration curve was plotted taking the concentration along X-axis and the spectrophotometric readings (absorbance) along Y-axis.

Accordingly the value of nitrate in the sample water was read in the form of nitrogen (NO_3-N) by comparing absorbance of the sample with the standard calibration curve plotted and saved former .The spectrometric reading was expressed in mg/L.The value of nitrate as nitrogen (NO_3-N) was corrected to normal nitrate by multiplying the result by its dilution factor (2.5 *) times the relative mass of nitrate to nitrogen.

Ammonia was analyzed using direct nesslerization method. In direct nesslerization method, Nessler reagent, Stock ammonium solution, Zinc sulfate solution, Standard ammonium solution, stabilize reagent (Rochelle salt solution), and 6N NaOH solution were prepared for the further analysis of ammonia from water sample. The usually present ammonia in the salt was removed by boiling30 mL of solution and diluted to 100 ml after cooling.

Nessler reagent was prepared by dissolving 50g HgI2 and 35g KI in a small quantity of distilled water and this mixture was further added slowly to a cool solution of 80g NaOH dissolved in 250mL of distilled water diluted to 1L. To maintain stability of the reagent, the reagent was stored in borosilicate glassware rubber stoppered and out of sunlight.

Stock ammonium solution for standard ammonia solution was prepared by dissolving 3.819g anhydrous NH4Cl and drying no hot plate at100°C. The residue was dissolved in ammonia free distilled water then diluted to 1L, 1ml=1.00mgN = 1.22mg NH3. Whereas the standard ammonium solution was prepared by diluting 10ml stock ammonium solution to 100ml of distilled water, 1ml=10µgN= 12.2µg NH3. Zinc sulfate solution was prepared by dissolving 50g ZnSO4.7H2O and diluted to 500ml with distilled water.

Series of standards of ammonium solution was again prepared by transferring 0.1,0.2,0.4,0.8 and 1ml of standard ammonium solution with concentration of 0.67,0.128,0.226,0.4 and 0.454 ammonia nitrogen µg /50 ml to a 50 mL volumetric flask stoppered graduated cylinder to plot calibration curve. These series of standards were nesslerized by adding 1.0 mL Nessler's reagent to each flask with a safety pipet. This mixture was mixed well using stopper and invert several times. Finally absorbance of this standard ammonium solution was read at 425 nm within10 minutes and calibration curve was plotted on the basis of absorbance versus concentration.

Ammonia was one of the main physicochemical components tested in all sampled water t from all sites. Enough amount of the sampled water (100ml) was measured using graduated cylinder. For instance of settling down the suspension, 1ml of zinc sulphate and 1ml of sodium hydroxide were added and mixed well by shacking manually. The mixture was kept for some time until the suspension full accomplished. Once the suspension was finished, 50ml of the mixture was poured to graduated cylinder and two drops of Rochelle salt and Nessler's reagent was also added again. Finally the absorbance of colour developed was read using spectrophotometer (DR5000) at 425nm. Spectrophotometer was read Ammonia in nitrogen form (NH3-N) and the reading was taken comparing against the standard calibration curve prepared using standard ammonia solution previously and expressed in mg/L. The spectromrometric reading was re corrected by multiplying the result by relative mass of ammonia to nitrogen.

Fig. 4. Sample water reduced to measuring cylinder for ammonia test

Stannous chloride method was also used for both orthophosphate and total phosphorus analysis. Stannous chloride reagent, ammonium molybdate, stannous chloride and sodium hydroxide were the four chemicals used for the orthophosphate and total phosphorus analysis. In the present study since stannous chloride method was used to test both orthophosphate and total phosphorus. Stannous chloride reagent for this method was prepared by dissolving 2.5g fresh SnCl2.2H2O in 100 ml glycerol. This mixture was heated on hot plate via stirred with a glass rod to hasten dissolution.

Stock phosphate solution was produced by dissolving 0.7165g an hydrous KH2 PO4 in distilled water and diluted to 1000 mL; 1.00mL = 500 µg PO_4^{-3} . Similarly standard phosphate solution was also prepared by diluting 10ml stock phosphate solution to 1L with distilled water, 1ml = 5.0ug PO_4^{-3}. Series of standard phosphate solution was prepared by transferring 0.05, 0.10, 0150.0.250 and 0.30ml standard phosphate solution with concentration of 0.014,0.035,0.0560.094,and 0.119 Phosphate µgL^{-1} to a 50ml volumetric flask stoppered graduated cylinder ,to plot calibration curve.

To 25ml of the filtered sampled water was treated by 2ml of ammonium molybdate reagent and about 4-5 drops of stannous chloride reagent was added into laboratory cups. Later these samples were heated on hot plate to evaporate to dryness. As vaporisation was finished the residues were removed from the cups by rubbing with 2ml of phenol disalphonicacid. The rubbed solution of the residues was further added to 20ml of distilled water. Again 7mls of potassium hydroxide was again added and brown cloudy suspension yellowish collared solution was developed. After about 10 min but before 12 min, the colour developed (absorbance) was of the mixture was read using Spectrophotometer (DR5000) at 690nm by comparing the reading to the calibration curve prepared using standard phosphate solution. A reagent blank was run using distilled water as sample. The value of phosphate was obtained by comparing the absorbance of sample with the standard curve plotted based on the standard phosphate solution prepared.

Macro invertebrates sample caught from every sampling site were identified using relevant identification keys(Subramanian *et al.,* 2007)and equipments like dissecting microscope and hand lenses. Likely the three wetlands under the present study were diversified with different macro invertebrate families. In total,30 different macroinvertebrate families were encountered in this study(Appendix3).

3.4. Data Analysis

3.4.1. Physico-chemical and nutrients

Significant variations in the mean values of physico-chemical parameters and nutrients among the three wetlands groups were tested using Kruskal-Wallis followed by Mann-Whitney pair wise post-hoc tests due to lack of homoscedasticity and normality in the data. Normality and homoscedasticity of the data were tested using Shapiro-Wilk and Leven statistics respectively. Benferroni p values corrected for multiple testing were used to evaluate significance of pair wise comparisons for the Mann-Whitney post-hoc tests. Spearman's correlation coefficient was used to test the possible correlations among the measured parameters. Statistical analyses were run in PAST version 3.08 and SPSS version 16.

3.4.2. Macroinvertebrates

The macroinvertebrate based multimetric index (MMI) developed by Mereta*et al*. (2013)for the southwest Ethiopia was used as biotic index to evaluate conditions of the wetlands. The index combines three metrics namely family richness, EOT family richness and % filter-collector. The MMI rates the ecological condition of a wetland with scores divided into five quality classes as 3–5 = very bad, 6–8 = bad, 9–11= moderate, 12–13 = good and 14–15 = very good.

4. Results

4.1. Variations of physico-chemical parameters and nutrients

A summary of the measured environmental variables for all the three wetlands is presented in Appendix 2. Table 2 summarizes statistical tests of variablesof the three wetlands.The analysis showed that pH varied significantly among the three wetlands.

Table2. Summary of the non-parametric tests of mean differences of the physico-chemical parameters and nutrients among the wetlands; Med = Median; Statistical significance was evaluated at 5%; significant p-values are indicated with asterisk (*).

		Water T		DO		pH		EC		BOD_5	
Wetland	N	Med	Mean Rank	Med	Mean Rank	Med	Mean Rank	Med	Mean Rank	Med	Mean Rank
Guji	14	21.40	12.86	6.21	6.60	6.99	11.11	62.00	13.29	2.26	14.79
BiloIlala	7	22.30	17.21	6.79	6.77	7.31	20.5	74.90	16	1.23	12.71
Kumbabe	8	23.50	16.81	6.02	7.18	7.28	17	119.85	17.12	1.55	17.38
Kruskal-Walis test											
Chi-Square		1.73			0.37	6.30		1.16	0.37		
Degree of freedom		2			2	2		2	2		
P		0.42			0.83	0.04*		0.56	0.83		

Table 2(Continued)

		TSS		NH_3		NO_3^-		PO_4^{3-}	
Wetland	N	Med	Mean Rank	Med	Mean Rank	Med	Mean Rank	Med	Mean Rank
Guji	14	0.005	13.15	0.14	18.54	0.67	13.64	0.45	12.11
BiloIlala	7	0.004	13.21	0.03	9.93	2.64	13.57	0.66	15.21
Kumbabe	8	0.007	19.06	0.06	13.25	3.09	18.62	0.81	19.88
Kruskal-Walis test									
Chi-Square	2.96			5.24			2.00	4.25	
Degree of freedom	2			2			2	2	
P	0.23			0.07			0.37	0.12	

The Mann-Whitney pair wise post-hoc tests for pH, the only variable that varied significantly among the wetlands, are summarized in Table 3.

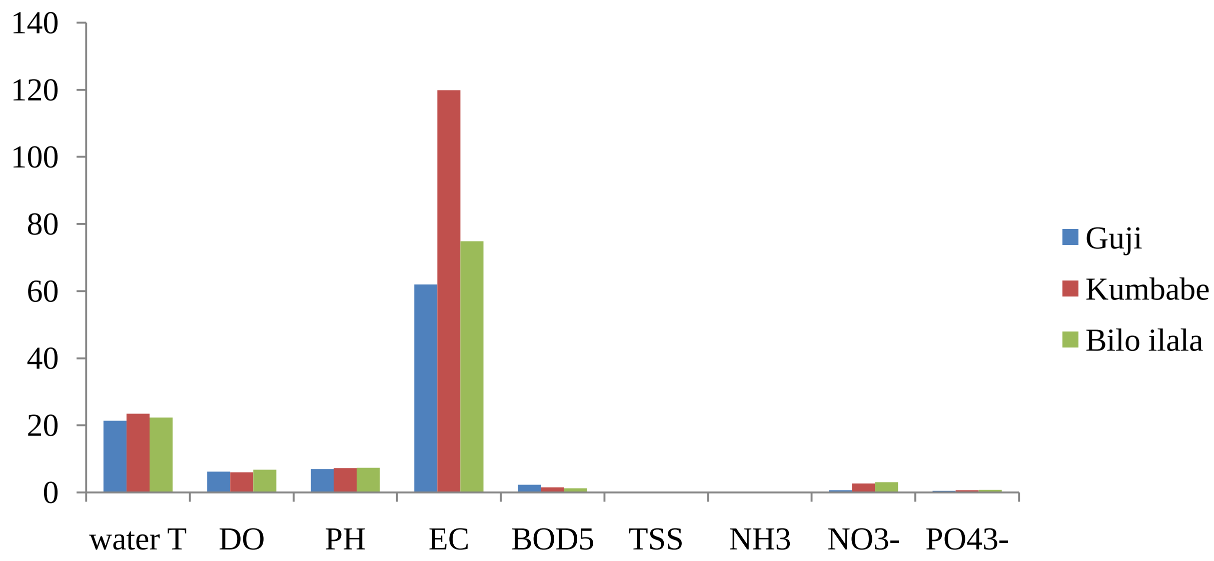

Fig.5. Summary of the non-parametric tests mean differences of the physico-chemical parameters and nutrients among the wetlands.

Table3. Summary of the Mann-Whitney pair wise post-hoc tests for pH only variable that demonstrated significant variations using Kruskal-Wallis test; Statistical significance was evaluated at 5%; significant p-values are indicated using asterisk.

	pH-Guji	pH-Kumbabe
pH-Guji		
pH-BiloIlala	0.05*	
pH-Kumbabe	0.40	1

Table4. Summary of linear correlation among selected variables using Spearman's rho coefficient (r); N= 29 for each variable; *Correlation is significant at 0.05 level (2-tailed).

		Water T			Water T	DO
DO	R	-0.52*	TSS	R	0.38*	-0.10
	P	0.00		P	0.04	0.63
pH	R	-0.41*	BOD_5	R	0.46*	-
	P	0.03		P	0.01	0.00
EC	R	0.29				
	P	0.13				

The average values of dissolved oxygen varied from 6.02 mg/L(Kumbabe) to 6.79 mg/L (BiloIlala). However, the variations in the dissolved oxygen among all the three wetlands were not statistically significant (P =0.63; Table 4). Nevertheless, the lowest amount of dissolved oxygen in Kumbabe wetland could relate to the highest water temperature of the wetland as comparethe other two wetlands. The correlation between the dissolved oxygen and water temperature is negative and statistically significant (r = -0.5*).

4.2. Macroinvertebrates

Table5. Summary of the multimetric index computed from the macroinvertebrate diversity according to Mereta et al. (2013)

	Family richness	EOT richness	%FC	Total MMI Score
Guji	25	9	8	-
MMI score	5	5	5	15
BiloIlala	19	6	10.5	-
MMI score	5	5	5	15
Kumbabe	17	5	11.8	-
MMI score	5	5	5	15

The multi metric index of the three wetlands was registered being in the very good category. This means that all families including are diversified in the similar way.

4.3. Habitat assessment

Table 6. Summary of the disturbance factors of the studied wetlands;Bilo = BiloIlala wetland; Kumb = Kumbabe wetland; 1 = minimum disturbance; 2 = moderate disturbance; 3 = Substantial disturbance (see Appendix 1)

	Habitat alteration			Land use	Hydrological modification	
Wetland site	Grazing	Vegetation removal	Tree plantation	Farming	Draining and ditching	Total score
Guji1	3	2	2	2	3	10
Guji2	3	2	2	3	3	11
Guji3	3	2	3	2	2	10
Guji4	3	2	2	2	2	9
Guji5	3	2	1	2	2	10
Guji6	3	2	2	2	2	9
Guji7	3	2	2	2	3	10
Average score	3	2	2	2	2	10
Bilo1	3	2	2	3	3	12
Bilo2	3	2	1	2	3	10
Bilo3	3	2	2	3	2	10
Bilo4	3	2	2	3	3	11
Average score	3	2	1	2	3	11
Kumb1	3	2	2	2	2	10
Kumb2	3	2	2	2	3	11
Kumb3	3	2	2	1	3	9
Kumb4	3	2	2	1	3	10

Kumb5	3	2	1	1	3	9
Average score	3	2	2	1	2	10

A given above in table 6 the overall result of the habitat disturbance score for the three wetlands under the present study was very similar. In these wetlands except grazing condition habitat characteristics are found in suitable ecological states.

a **b** **c**

Fig.6.Grazing conditions of Bilo(a), Guji(b) and Kumbabe wetland(c) in dry season

5. Discussion

Temperature is a factor of great importance for all aquatic ecosystems, as it affects the organisms, as well as the physical and chemical characteristics of water.The average water temperature of wetlands in the present study was varied from 21.4°C(Guji) to 23.5°C(Kumbabe). However, the variation was statistically not significant ($p = 0.42$; Table 2). The highest water temperature in Kumbabe wetland could be due to altitude variation in relation with the other wetlands (Table 1). According to Yimer and Mengistu,(2009)the vegetated wetlands are expected to have the lowest temperature because the wetland plants as well as the upland plantations cast shadow.Therefore on the base of this concept the highest water temperature in Kumbabe wetland is could be again as a result of the intensive grazing condition in this wet land. Whereas the lowest water temperature in Guji wetland could be due to partially shaded regions of the sampling sites.

A water temperature of the present study was obtained being a bit higher than water temperature mean values in the other study in surface water of Camlıgoze Dam Lake which was 19.75°C (Dirican*et al*., 2009). Being so, a water temperature obtained in the present study was register being within the acceptable range for aquatic organisms compared to the range of (WHO, 1988) and Dirican (2015). On the bases of this comparative description the average water temperature in the assessed wetlands arefound within the permissible limit .Thus, the average temperature of the wetlands is favorable for aquatic ecosystem.

In the present study the average values of dissolved oxygen varied from 6.02 mg/l (Kumbabe) to 6.79 mg/L (BiloIlala). Nevertheless, the lowest amount of dissolved oxygen in Kumbabe wetland could relate to the highest water temperature of the wetland as compared to the other two wetlands. Similarly, the highest dissolved oxygen value for BiloIlala wetland could relate to the low level ofTSS, NH_3, NO_3^- and $PO_4^{3-}$of all wetland. The overall result of DO in the present study was obtained being higher than DOin the other study around Jimma town at Koffe, Boye and Kitto wetlands which was 1.69, 6.34 and 6.21mg /L respectively (Yimer and Mengistu, 2009). Variation the present study and the former study shows that the study sites under these two studies are very differ in ecological threat level.According to Jackson and Myers, (2002) amount of DO in aquatic bodies directly relate to the population size and community of aerobic bacteria the aquatic system can support. The test for biochemical oxygen demand (BOD) is a bioassay procedure that measures the oxygen consumed by bacteria from the decomposition of organic matter (Sawyer and McCarty, 1978).According to classification continental inland water sources of Turkish water pollution control regulation (2008), if dissolved oxygen is 8mg/L the water is class-I; if it is 6 mg/ L the water is class-II; if it is 3 mg/ L, the water is class-III and if dissolved oxygen is <3 mg L^{-1}, the water is class-IV. Therefore according to these limits, water in Guji, BiloIlala and Kumbabe wetland could be categorized as class-II. According to USEPA,(2000) and Egemen (2011), in inland ecosystems, the minimum dissolved oxygen may not be less than 5.0 mg/ L for aquatic life. On the base of these three references, the average DO results obtained in the three wetlands concise the normal states in all the three wetlands. This also indicates that the three wetlands are free from high lodes of different organic molecules.

The pH values of the assessed wetlands varied from slightly acidic 6.99 (Guji) to 7.31 (BiloIlala).The higher concentrations of pH in BiloIlala could relate with the highest grazing condition, TSS values, $NO_3^-$and PO_4^{3-}. In the other study, a bit low pH mean values 6.42 to 6.86 was determined in surface water of Himalayan wetland Deoriatal (Anita., 2018).According to the USEPA (1980), accepted water quality criteria indicate, a pH of less than 6.5 units may be harmful to many fish species .Dirican(2015) states the pH range of 6.5-9.0 units would be suitable for the protection of aquatic habitats. Therefore, the pH range of 6.99-7.31 in the present study would be suitable for the protection of aquatic habitats.

According to the USEPA (1980), the values of pH were normal in Guji, Bilo and Kumbabe wetlands. On the basses of Jitendraet al.,(2008) ,Egemen, (2011) and Soni*et al*.,(2013) the pH values obtained in this study were adequate for aquatic life including fish within recommended range of 6.5-8.5units. According to Turkish water pollution control regulation, a pH value between 6.5 and 8.5 should be obtained if lake, pond and Dam Lake reservoirs are naturally protected area. Accordingly Guji, BiloIlala and Kumbabe wetlands can be said naturally protected areas.

The average electric conductivity of the wetlands in the present stud varied from 62 µS/cm (Guji) to 119.85 µS/cm (Kumbabe) but the variations were statistically not significant ($p = 0.56$; Table 2). Electric conductivity correlated positively with water temperature but the relationship was statistically not significant ($r = 0.29$; $p = 0.13$). The lowest EC value in Guji wetland could be correlated to the low value of water temperature, pH and PO_4^{3-}.Whereas the highest EC value in the Kumbabe wetland was also correlated with the highest value of temperature, NO_3^- and PO_4^{3-} aswell as intermediate pH value.As a report of former study in at Ratoli village EC was registered been ranging500- 800µS/cm (Pingalkar, 2018). In relation to this study result the present record in Guji, BiloIlala and Kumbabe wetlands were obtained being very much lower.Such lower conductance therefore shows absence pollutant loads.In the present study the overall EC value in the three assessed wetlands were registered being within the permitted range of (WHO,2006). The recommended value of conductivity for portable water is 2500 µmhos/ cm (WHO, 2006). According to Polat(1997), when conductivity is over that 1000 µmhos /cm, it means that pollution occurs in lake.Therefore, since the EC is blow this limit of WHO and optimum for ecological concerns the water systems in the wetlands are very fine.

The average TSS values for the wetland varied from 0.004 mg/L (BiloIlala) to 0.007 mg/L (Kumbabe). The highest water temperature and the highest average disturbance score of the five habitat conditions were the two conditions contributed to the highest TSS in Kumbabe wetland.Whereas the lowest value of the BiloIlala could be as a result of the lowest temperature.As a similar research of Israel(2007)reported TSS value was registered being ranging 8-12m/l. TSS value in the present study was lower when compared to(2007).However, the variations among the wetlands are not statistically significant.

The median values of NH_3, NO_3^- and PO_4^{3-} varied from 0.06 mg/L (BiloIlala) to 0.14 mg/L (Guji), 0.67 mg/L(Guji)to 3.09 mg/L (Kumbabe) and 0.45 mg/L (Guji) 0.81 (Kumbabe) respectively. However, variations of all the three variables were statistically not significantly among the wetlands ($p > 0.05$; Table 2). Fertilizer, livestock manure, and human sewage can be significant contributors of nitrates in groundwater sources of drinking water (Hunter,(2008) andUSEPA,(2009)) .Therefore the highest NH_3 and NO_3^- concentration in Kumbabe wetland could be related with the extensive grazing condition. Cattle grazing can have a strong impact on wetlands by increasing nutrient inputs via urine and fecal deposition or via trampling of sediments, which in turn can affect the organisms that rely on this habitat (Steinman and Rosen,2000;Steinman etal.,2003).Similarly grazing also reduce the rate at which nitrate up taken by plants. Therefore in intensively grazed area of Kumbabe wetland increase in nitrate was the result of this case.

According to classifical continental inland water sources of the Turkish water pollution control regulation ,(2008), if nitrate is 5 mg/ L, the water is class-I; if it is 10 mg/ L the water is class-II; if it is 20 mg /L the water is class-III and if nitrate is >20 mg /L the water is class-IV. On the base of this limit the three wetlands have high water quality standard. Nitrate is again recorded being in the suitable range.

The orthophosphate values obtained in the present study is normal for aquatic ecosystems within recommended range of 0.05-0.3 (Cirik and Cirik, 2008). According to Bulut*et al*. (2011), when phosphate concentration isover 0.30 mg/L, it means that eutrophication occurs in lake. Accordingly one can conclude that eutrophication can be a case in BiloIlala, Guji and Kumbabe wetlands. On the basis of this limits, PO_4^{3-} in the present study is obtained being above the referred limits. The increased in PO_4^{3-} can be obtained as a result of agricultural water leaching from adjacent uplands and teff farms within the wetlands.

The multi metric index(MMI) of the macroinvertebratesrevealed the water condition in Guji, BiloIlala and Kumbabe wetland was very good. This means that water in the assessed wetlands is ecologically safe for aquatic organisms and no pollutant chemicals observed above standard limits. The MMI scores for all the wetlands fall in the range of very good wetland condition (MMI = 15). As it is given above in Table5 the minimum family richness recorded in Kumbabe wetland (17)could be relatedhighestgrazing and highest PO_4^{3-}concentratoin where asthe maximum family riches (25) in Guji wetland could be related with the lowestgrazing.

Assessment of status of the wetlands based on the disturbance factors is summarized in Table 6. Overall, the scoring indicated by “1” refers to minimal disturbance, “2” refers to moderate disturbance and “3” refers to substantial disturbance. The details of the scoring for each factor are provided in Appendix 1. Thus, as five major disturbance factors were used for assessment, the total score was computed out of 15.

As indicated in Table 6, grazing has the highest impact on all the three wetlands and all the other factors have moderate to least impacts on the wetlands. The maximum average score of habitat disturbance obtained in BiloIlala shows that it has Substantial ecological disturbances. The intensive grazing condition also could contribute to vary differently. Likely pH was obtained slightly alkaline assist the increment of nitrate too. Since grazing disturbs habitat status it also contributed for the reduction of themacroinvertebrate family richness among the wetlands.

6. Conclusion and recommendations

6.1. Conclusion

The results obtained from the present study shall be useful in future for management of the Guji, BiloIlala and Kumbabe wetlands. Thephysico-chemical assessed in present study in Guji ,BiloIlala and Kumbabe wetlands were water temperature, pH, DO,EC,TSS, Nutrients (NH_3, NO_3^-, PO_4^{3-})and BOD_5. The obtained results of mostphysico-chemical parameters assessed in the study were statistically not significant. The determined variables were within the ecological conducive range for aquatic life.Similarly MMI of macroinvertebrates and average habitat disturbance score revealed that there is very good ecological conditions. But in all assessed wetlands grazing condition was extensive challenge to the wetlands. Generally the overall water statuses of the three wetlands are founded being in normal ecological standards.

6.2.Recommendations

For the future local governmental organization who is concerned shall be take part in preserving these wetlands by giving more care. In order to aware the public to the values and functions of wetlands and the need for their wise use, a series of public awareness campaigns are needed.In order to maintain ecological status of these wetlands grazing should be regulated or monitored. Now days since ecological coverage of such naturally preserved area are being reduced these wetlands must get better ecological cares.

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Appendix 1. Criteria and disturbance score used for assessing wetland status as reference and impaired (degraded) wetland sites (Modified from Mereta et al., 2013). A score of 1 was awarded for no or minimal disturbance, 2 for moderate disturbance and 3 for high disturbance.

Disturbance score		Score =1	Score = 2	Score = 3
Habitat alteration	Grazing	Minimal grazing	Moderate grazing	Intensive grazing
	Vegetation removal	<10% vegetation removal	10-50% of vegetation removal	>50% vegetation removal
	Tree plantation	No tree plantation or plantation at >50m	Tree plantation at < 50m but not in the wetland	Tree plantation in the wetland
Land use	Farming	No farming or farming at > 50 m from the wetland	Farming in a distance of <50 m from the wetland	Farming in the wetland it self
Hydrological modification	Draining and ditching	No draining nor ditching	Draining nearby < 50 m	Draining in the wetlands

Appendix 2. Summary of Environmental parameters measured during the study period; Bilo =BiloIlala wetland; Kumb = Kumbabe wetland

Wetland sites	Water temp (°C)			DO (mg/L)			pH			EC (µS/cm)			TSS (mg/L)		
	Wet	Dry	Mean	Wet	Dry	Mean	Wet	Dry	Mean	Wet	Dry	Mean	Wet	Dry	Mean
Guji 1	21.2	21.8	21.5	6.84	0.97	3.91	6.43	6.61	6.52	25.6	67.3	46.45	0.002	0.0186	0.010
Guji 2	23.3	18.6	20.95	6.71	5.7	6.21	6.9	7.08	6.99	39.2	90.3	64.75	-	0.002	0.002
Guji 3	20.5	21.7	21.1	7	2.48	4.74	7.23	7.08	7.16	33.4	156.9	95.15	0.007	0.002	0.005
Guji 4	20.5	21.6	21.05	6.98	1.09	4.03	7.51	7	7.26	31.2	190.1	110.65	0.005	0.002	0.003
Guji 5	20.7	27.8	24.25	6.89	1.21	4.05	6.93	6.82	6.88	36.2	161.9	99.05	0.006	0.050	0.028
Guji 6	20.4	22.2	21.3	7.05	1.01	4.03	7.16	6.93	7.045	56.7	218.3	137.5	0.007	0.0004	0.004
Guji 7	20.4	23	21.7	6.94	0.88	3.91	7.83	6.97	7.4	35.4	327	181.2	0.006	0.003	0.004
Bilo 1	20.8		20.8	6.96		6.96	7.23	-	7.23	126.3		126.3	0.0001		0.0001
Bilo 2	20.5	28.1	24.3	7.35	0.96	4.155	7.5	7.14	7.32	74.9	141.6	108.25	0.002	0.009	0.005

Bilo3	20.3	27.8	24.05	6.79	1.34	4.065	7.93	7.1	7.515	74.4	176.4	125.4	0.003	0.004	0.004
Bilo4	22.3	29	25.65	7.02	4.14	5.58	7.46	7.31	7.385	43.7	72.7	58.2	0.012	0.008	0.010
Kumb1	20		20	6.68		6.68	7.71		7.71	115.2		115.2	0.005		0.005
Kumb2	19.7	26.5	23.1	7.34	0.47	3.905	7.38	6.82	7.1	134.8	226	180.4	0.007	0.526	0.266
Kumb3	20.6	30.2	25.4	5.74	7.88	6.81	7.66	7.35	7.505	128.9	89	108.95	0.006	0.519	0.262
Kumb4	24.8		24.8	5.66		5.66	7.04		7.04	45.3		45.3	0.004	0.536	0.270
Kumb5	22.2	31.1	26.65	6.3	0.42	3.36	6.97	7.2	7.085	63.8	124.5	94.15	0.001	0.556	0.279

Appendix 2 (Continued)

	NH_3 (mg/L)			NO_3^- (mg/L)			PO_4^{3-} (mg/L)			BOD_5 (mg/L)		
Sites	Wet	Dry	Mean	Wet	Dry	Mean	Wet	Dry	Mean	Wet	Dry	Mean
Guji1	0.311	0.126	0.219	0.289	4.56	2.425	0.448	0.75	0.599	0.94	4.24	212.47
Guji2	0.021	0.095	0.058	0.244	4.14	2.192	0.487	0.9	0.694	0.65	4.45	22.575
Guji3	0.32	0.129	0.225	0.238	3.32	1.779	0.121	0.99	0.556	0.57	3.27	16.635
Guji4	0.188	0.117	0.153	0.255	2.75	1.503	0.093	0.27	0.182	1.25	4.25	213.125
Guji5	0.313	0.752	0.533	0.094	0.863	0.479	0.709	0.63	0.670	0.73	3.92	196.365
Guji6	0.02	0.197	0.109	0.217	3.708	1.963	0.405	0.33	0.370	0.76	3.36	84.63
Guji7	0.093	0.144	0.119	0.47	2.911	1.691	0.454	0.36	0.407	0.95	4.24	212.475
Bilo1	0.019		0.019	2.734		2.734	0.682		0.682	0.66	-	0.66
Bilo2	0.01	0.097	0.054	1.441	2.643	2.042	0.489	0.36	0.425	1.23	4.97	249.115
Bilo3	0.023	0.144	0.084	0.716	2.9	1.808	0.371	0.66	0.516	0.54	4.5	112.77

Bilo4	0.034	0.112	0.073	0.041	3.63	1.836	0.964	0.69	0.827	0.7	3.91	39.45
Kumb1	0.093		0.093	2.867		2.867	0.804		0.804	1.68	-	1.68
Kumb2	0.018	0.121	0.070	5.254	3.033	4.144	0.846	0.36	0.603	1.42	4.49	2.955
Kumb3	0.033	0.212	0.123	3.199	2.18	2.690	1.524	0.36	0.942	0.8	3.45	2.125
Kumb4	0.035	-	0.035	3.143	-	3.143	0.744	-	0.744	1.37	-	1.37
Kumb5	0.02	2.665	1.343	3.586	0.099	1.843	1.308	0.81	1.059	1.13	4.67	2.9

Appendix 3. Summary of the macroinvertebrate diversity identified for the three wetlands during the study period; FFG = functional feeding group.

Order	Family	FFG	Abundance		
			BiloIlala	Guji	Kumbabe
Odonata (damselflies)	Aeshnidae	Predator	4	0	1
Ephemeroptera (Mayflies)	Baetidae	CG, Scrappers	16	0	0
Hemiptera (Water bugs)	Belostomatidae	Predator	49	39	17
Trichoptera (Caddisflies)	Beraeidae	CG (Shredder, Grazer)	0	5	0
Odonata (damselflies)	Calopterygidae	Predator	0	23	0
Diptera (Flies)	Ceratopogonidae	Predator	1	0	0
Diptera (Flies)	Chironomidae	CG (Sc, FC, P)	11	9	164
Odonata (damselflies)	Coenagrionidae	Predator	28	26	16
Hemiptera (Water bugs)	Corixidae	CG	18	9	30
Megaloptera	Corydalidae	Predator	0	0	40
Diptera (Flies)	Culicidae	FC, CG	4	0	35
Trichoptera (Caddisflies)	Ecnomidae	Predators	0	34	1
Hemiptera (Water bugs)	Gerridae	Predator	1	12	0
Coleoptera (water beetles)	Gyrinidae	Predator	25	58	125
Annelida (Haplotaxida [Earthworm])	Haplotaxidae	CG	2	2	0
Ephemeroptera (Mayflies)	Heptageniidae	CG	0	11	0
Annelida (Arhynchobdellida)	Hirudinidae (Leeche)	Parasite	6	9	0

Hemiptera (Water bugs)	Hydrometridae	Predator	0	3	0
Coleoptera (water beetles)	Hydrophilidae	Predator (Larvae), CG (Adults)	2	64	24
Coleoptera (water beetles)	Hydroscaphidae	Scraper	2	25	25
Odonata (dragonflies)	Libellulidae	Predator	24	97	24
Odonata (damselflies)	Lestidae	Predator	60	0	0
Mollusc (Gastropoda)	Lymnaeidae(feshwater snails)	Scraper	0	4	4
Hemiptera (Water bugs)	Nepidae	Predator	0	6	0
Trichoptera (Caddisflies)	Philopotamidae	FC	0	9	0
Hemiptera (Water bugs)	Pleidae (Pygmy Backswimmers)	Predator	0	154	125
Crustacea (Decapoda)	Potamonidae (freshwater crab)	Predator (Omnivore)	11	5	0
Odonata (damselflies)	Psychodidae	CG	3	3	0
Trichoptera (Caddisflies)	Rhyacophilidae	Predator	0	10	14
Mollusc (Veneroida [Bivalvia])	Sphaeriidae (freshwater clams)	FC	60	3	15
Diptera (Flies)	Tipulidae Crane flies)	Shredders (P, CG)	0	25	1