ECOSYSTEM SERVICE IMPLICATIONS ON THE ECOLOGICALSTATUS OF KOROK,AMODOJODO, BOBO AND AKIDI WETLANDSIN ABOLWEREDA, GAMBELLA REGION, WESTERN PART OF ETHIOPIA

BY:

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THESIS SUBMITTED TO DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCE ANDTECHNOLOGY, FACULTY OF PUBLIC HEALTH, INSTITUTE OF HEALTH SCIENCE, JIMMA UNIVERSITY IN PARTIAL FULFILLMENT FOR THE REQUIREMENTS OF MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCEAND TECHNOLOGY

NOVEMBER , 2018

JIMMA, ETHIOPIA

JIMMA UNIVERSITY

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DEPARTMENT OF ENVIRONMENTAL SCIENCE AND TECHNOLOGY

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DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in this or any other university and that all sources of materials used for the thesis have been fully acknowledged.

Name: ______________________________

Signature: ____________________________

Name of the institution: _________________

Date of submission: ____________________

This thesis has been submitted for examination with my approval as University advisor

Name and Signature of the first advisor ____________________________________

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ABSTRACT

Wetlands are among the most productive ecosystem services environments in the world and are critical for supporting human livelihoods in Africa. Provide to human populations include food, water quality maintenance, agricultural production, fisheriesand recreation.Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. If water table is at or near the surface of the land.The main objective of this study was to assess the ecosystem servicesand identified physicochemical and biologicalcharacteristics on Korok, Amodojodo, Bobo and Akidi wetlands in Abol wereda Gambella region.Focus group discussion (FGD) was conducted separately in six groups: males, females and youth each have 8 to 12 membersof participants. In total six FGDs were made from both groups for ecosystem services providing to the surrounding communities. Among the four wetlands Korok and Amodojodo are providing the ecosystem services to the surounding communities such as crop production, fishing, grazing, domestic purposes and vegetable (tomato) cultivation and raw materials (such as thatching grass, medicinal plants and firewood) during dry season. These two wetlands were much closed to the communities. Physicochemical, macroinvertebrate and birds samples were collected from 18 sampling sites. Physicochemical parameters such as DO,pH, water temperature,sludge depth and water depth were measured on field used astandard methodMulti-Parameter Digital probe andfor other chemical paramere water samples were collected, stored in a refrigerator at $4^{\circ}C$ transported to jimma and analysed in the laboratory were follow according to the procedure set by APHA. Qualitative data analysis, data from FGD was transcribed, coded and manually to identify the ecosystem services and associate it with the wetlands water quality,macroinvertebrates diversity and birds.PCAbiplot analysiswas applied used PASTsoftware to identify factors influencemacroinvertebrate assemblages.Finally, it concluded that the wetlands thatwerehigher ecosystem services there were lower macroinvertebrate assemblages. Environmental variables such as phosphate, ammonia,TN, phoshphate, chloride, TSS, EC,water tempereture, sludge depthand pH disturbances structure were predominantly affecting the macroinvertebrate assemblages and birds under the study area in the area. Macroinvertebratemetrics and birds biotic indices (FBI andBMWP) were lower at most sites of the fourwetlands. Conservation of wetlands is needed from government.

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Table of Content

Contents Page

LIST OF TABLES Page

LIST OF FIGURES Page

LIST OF ANNEXES Page

LIST OF ACRONYMS AND ABBREVIATIONS

APHA= American Public Health Association

BMWP = Biological Monitoring Working party

DO= Dissolved oxygen

EO= Ephemeroptera and Odonata

FBI =Family level Biotic Index

FGD=Focus group discussion

PAST=Paleontological Statistics

PCA= Principal Component Analysis

TH= Total hardnes

TN = Total Nitrogen

TSS = Total Suspended Solid

CHAPTER ONE: INTRODUCTION

1.1. Background

Wetlands are areas that are saturated with water long enough to cause the formation of waterlogged (hydro) soils and the growth of water loving (hydrophytes) or water tolerant plants (McCartney,2014).Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by shallow water. Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Wood, 2001).Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. They also are a source of substantial biodiversity in supporting numerous species of all the major groups of organisms from microbes to mammals. Physical and chemical features such as climate, topography, geology, nutrients, and hydrology help to determine the plants and animals that inhabit various wetlands. Wetlands contribute in diverse ways to the livelihood of many people and biodiversity in Africa. One of the major constraints to the judicious use of African wetlands is lack of knowledge byplanners and natural resource managers of the benefits that Wetlands contribute in diverse ways to the livelihood of many people and biodiversity in Africa.

One of the major constraints to the judicious use of African wetlands is lack of knowledge by planners and natural resource managers of the benefits that they provide and techniques by which they can be utilized in a sustainable manner (Jago and Hassain, 2010). Consequently, owing to a lack of scientific investigation and inconsistent mapping policies in Africa, the total extent of wetlands on the continent is still unknown (Schuyt, 2005). Because of its wide variety of landforms and climatic conditions Gebresllassie*et al.*,(2014), an extensive wetland system is created throughout Ethiopia. As such, wetlands produce an ecological equilibrium in the environment by maintaining the integrity of life support systems for sustainable socio-economic development.

Generally, wetland ecosystem values range from tangible persistence uses and direct benefits to intangiblegoods and services and the fulfillment of human needs. 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. The direct use also includes practice agricultural, fishing, fiber production, water supply, recreational opportunities and increase tourism (Gebresllassie*et al*.,2014)Natural and anthropogenic activities within a watershed influence the functions of wetlands. When these activities remain relatively constant, the functions of natural wetlands tend to exist in dynamic equilibrium with the surrounding conditions. However, changes in the established combination of natural and anthropogenic activities within a watershed can result in dramatic changes in the functions of natural wetlands. The physical, chemical, and biological characteristics of natural wetlands combine to determine unique wetland types. Differences in these characteristics range from subtle to obvious among different wetland types depending on many factors associated with wetlands that include: hydrology, biological functions, site-specific factors, the climate and geology of the region, landscape, and soils. These factors are dependent, and form a complex interrelationship to make each wetland type unique. An assessment of the current status of these factors for a particular wetland is important to understand the effects of certain factors, such as increased or decreased quantities of storm water runoff, on an individual wetland. For example, by changing the hydrology of a wetland, the water retention and sediment attenuation functions can be lost, resulting in downstream hydrological and water quality impacts; or vegetative species and composition within and surrounding a wetland might change, resulting in habitat quality changes (USEPA,1996).

1.2. Statement of the problem

Wetlands are the most productive ecosystems on earth; however, they are also the most threatened (Sarron, 2005). Humans usually and very dramatically accelerate natural processes often unintentionally but usually in the course of activities like crop production, canalization, effluent disposal, water abstraction, industry, and urban development. These activities can involve anything from drainage and diverting water to dredging and loading water sources with toxic chemicals (Sarron, 2005). Perhaps the most destructive of all activities is mining (Beasley and Kneale) which permanently destroys the substrate and prevents the natural restoration of a site. The results of wetland loss are far-reaching and disastrous. Humans and other life close to wetlands, and who depend upon them, are the first to feel the impact of wetland loss. Dam construction can significantly impact the lives of people living downstream; as waters are regulated (Finlayson *et al.,* 1996) Animal and plant life dependent on a dammed river's annual floods may be exterminated or become endangered. Dams affect flooding cycles, water chemistry, sediment behavior and fish migrations (Matza and Crafter, 1994). Dam seriously affects the downstream ecosystem; reduction of water discharge, exposure of the bottom substrate to people to access the watercourse for firewood collection, fishing, and stone collection which in turn resulting in reduction of biodiversity and water quality (Ambelu*et al*, 2013) Wetland functions, including flood protection, nutrient retention, erosion control or sediment retention, will be compromised by well-meant development interventions. However, once a wetland has been destroyed, the services it previously provided now have to be paid for by tax payers (Finlayson *et al*., 1996). Examples of wetland services artificially performed by human interventions are water purification and erosion control schemes (Finlayson et al., 1996). While industrialized countries can probably pay for most of these services from tax incomes, this is not so in developing countries, where wetland destruction can have a very serious impact on the livelihoods of the rural poor.

In developing countries like Ethiopia, wetland destruction and alteration has been and is still seen as an advanced mode of development, even at the government level (Gebresllassia*et al.*, 2014). While the functional and economic values of wetlands are increasingly recognized, development projects continue to lead directly or indirectly to their loss. Irrigated agriculture for instance, has been destructive in the past, and has the potential to continue to do so in the future unless better management processes are established in the developing countries(Gebresllassia*et al.,* 2014) Yet, many wetland ecosystems particularly floodplains and swamps are regarded as wastelands and continue to be depleted at an alarming rate throughout Ethiopia. Moreover, national economic policies that prioritize crop production, severely affects sensitive ecosystems including wetlands through extensive land development schemes that have no concern for environmental costs (Gebresllassie et al 2014). The causes of wetland degradation include the conversion of wetlands for intensive irrigation agriculture, the expansion of human settlement, industrial pollution, pesticides and fertilizers and water diversion for drainage and the construction of dams (Abebe and Geheb). Wetland conversion often results in water depletion, the displacement of populations, the destruction of traditional production systems, habitat degradation, increases of waterborne diseases and other adverse ecological impacts (Matza and Crafter, 1994). The effect of nutrient inflows on wetlands results in eutrophication by numerous pathways; the phosphorus, nitrate and potassium loadings were drawn to surface water from a nearby farm (Matza and Crafter, 1994). The early indication of the occurrence of nitrate enrichment within wetland systems is indicated by indicator vegetation present (USEPA, 1996; Kennedy and Murphy 2004).

The desire to turn a quick profit and failure to use integrated planning strategies with no concern for ecological and social values, have already had a detrimental impact on Ethiopia. Loss of wetlands reduces biodiversity as the plants and animals that are adapted to wetland habitats are often unable to adapt to dry environmental conditions, or to move to more suitable ones. Loss of harvestable resources also occurs when wetlands are lost. Reduction of water quality and flow regulation is and additional consequence of loss of wetlands, and may result in greater extent or severity of flooding (Sarron, 2005).Wetlands loss is increasingly becoming an environmental disaster and the rates of their loss are documented for the developed world; but the limited study of these ecosystems in countries like Ethiopia leaves us with little to say. In other words, Researches on the status and trends of freshwater macro invertebrates have not been given much attention in tropical Africa compared to non-tropical regions (Elias et al., 2014). While most of the threats that wetlands face result from their misuse, 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 (Gebresllassia*et al.*, 2014). Many temporary wetlands have features that disappear, reappear and recreate themselves over time (Gebresllassia*et al.*, 2014). Due to habitat degradation by human activities such as industrialization, agriculture, and urban development, freshwater macroinvertebrate species are at higher risk of extinction (Elias et al., 2014). As a result, some species may already have become extinct even before they were taxonomically classified leading to lack of taxonomical information. This situation has hindered the potential use of benthic macroinvertebrates as indicators for water quality assessment (Elias*et al*.,2014).

Therefore, there were no studies conducted at the area of those wetlands in Gambella region. The information obtained from this study may further be used as an input for development of assessment tool which can be used by decision making organizations for wetland management system.

1.3. Significance of the study

Macroinvertebrates are known for their potential indicators of water quality in different parts of the world. This study was conducted to determine the ecosystem services providing by the wetlands and influence of environmental factors on macro invertebrate and birds inGambella wetlands of Abolarea south western part of Ethiopia. Aimed of this study to:

- Providingmore information on the ecosystem services of wetlands in Gambella region
- Giving information on water quality of the four wetlands in Gambella region.
- Delivering information on diversity of macro invertebrate assemblages and birdsdiversity inGambellaregion wetlands.
- It might helps to get information base on biological integrity in the study area.
- Might give a baseline data on ecosystem services, water quality,macroinvertebrate and birds inGambella wetlands area and might also provide an insight for future large scale research.
- This study can be findings used by local,wereda, zonal and state level concerning bodies to plan, regulate and manage Wetlands in Gambella region.

CHAPTER TWO: LITERATURE REVIEW

2. 1.Wetland ecosystems services

Ecosystems services of wetland including rivers, lakes, marshes, rice fields, and coastal areas, provide many services that contribute to human well-being and poverty alleviation. Some groups of people, particularly those living near wetlands are highly dependent on these services and are directly harmed by their degradation (Millennium ecosystem assessment, 2015). Two of the most important wetland ecosystem services affecting human well-being involve fish supply and water availability. Inland fisheries are of particular importance in developing countries, and they are sometimes the primary source of animal protein to which rural communities have access. Wetland related fisheries also make important contributions to local and national economies. (Millennium ecosystem assessment, 2015).

The principal supply of renewable fresh water for human use comes from an array of inland wetlands, including lakes, rivers, swamps, and shallow groundwater aquifers. Wetlands always have a role to play and are parts of human life. They have been parts of civilization and support the social needs and help to maintain environmental balance. There are different definitions to describe these wetland functions and values. Wetlands provide a number of resources for people and animals living nearby, the most important of these being water itself. They provide a reliable and relatively clean source of drinking water for the local population and their livestock, and for local wildlife. They also provide dry season grazing for livestock. Other resources provided by a wetland, often of greater importance to the poorer members of the community, include reeds for roof thatching and basket making, clay and sand for brick making and a source of plants used in traditional medicine and fish for food (Wood, 2003).

Finally, wetlands are invaluable for the dry season cultivation of crops, have a high productivity, and can sometimes support up to three crop cycles a year in areas of high rainfall, due to the continuous supply of water and nutrients. Wetlands can be managed for agriculture in a sustainable way provided the water balance and natural biota of the wetland are not irreversibly altered by the interventions (Dixon & Wood, 2003).

2.2.Biodiversity

Wetlands provide a habitat for many species of plants, animals and other organisms that depend on the reliable source of water and nutrients in the wetland to survive, and cannot live elsewhere. These are wetland dependent organisms, and are those most at risk if a wetland is threatened. Many animals, especially birds, use wetlands as a source of food, water and shelter but do not rely entirely on wetlands as their habitat. Many plant species grow well in wetlands due to the ample water and nutrients they provide, but are not obligate wetland plants as they are found in other habitats too. These are wetland associated organisms, as defined by ZerihunanKumlachew (2003).

Habitats due to the high productivity of wetlands and the fact that many have quite complex niche structuring, providing a variety of microhabitats for different species, which form a continuum of different. The overall species diversity of a wetland can be functional diversity higher than surrounding microhabitats from a dry terrestrial to an aquatic environment. All the above attributes of wetlands mean they have a highl*y*, a recognized element of the total biodiversity of an area at the (Zerihun, 2000).

2.3. Hydrological function

Wetlands provide a number of important in regulating water flow through a hydrological system. They slow the speed of water moving through the system and act as natural reservoirs, storing large amounts of water. This regulates the downstream flow, maintaining it during the dry season and controlling flooding during the wet season. Wetlands recharge groundwater and are important for maintaining the water table. All of these factors are extremely important for communities living and farming around or downstream of a wetland. Any changes to the wetland itself or the hydrological regime upstream of the wetland will have consequences for these functions (Dixon & Wood, 2003).

Large wetlands can also have an effect on rainfall, humidity and stabilization of the local microclimate through the high potential transpiration rates of dense wetland vegetation (Messele, 2003). Wetlands act as efficient filters for cleansing and stripping water of soluble nutrients from agricultural run-off and contamination by heavy metals and other pollutants. They also provide filters for waste water and sewerage, provided there is a balance between in and outflow.

Wetlands trap large amounts of sediment and therefore prevent sediment and nutrient loss from the system, which is important in regions with high soil erosion.

2.4. Wetlands degradation

There is increasing pressure on African wetlands as the human population continues to grow, and more land for agriculture and development are needed. The threats posed to wetlands by this development are therefore becoming increasingly acute and the rate of wetland loss is increasing (Schuyt, 2005 and Denny, 1994).

Some of the main threats to wetlands are outlined below. Physical alteration of the hydrology of the drainage basin of a wetland will affect the input of water to a wetland and/or its outflow. The construction of dams above or below a wetland will either reduce or increase the water flow to such an extent that the wetland is permanently damaged. Artificial stabilization of water levels by damming would also harm a wetland since the rise and fall of the water level drives nutrient cycling. Drainage of a wetland or unsustainable extraction of groundwater in the area will dry it out and may cause permanent damage, and will impair a wetland’s ability to control flooding, since the soil has a reduced capacity to reabsorb water (Berhanu, 2003).

One of the main threats to wetlands, especially ones in or close to urban settlements, is development. A wetland can be completely removed by filling in and building over the wetland area, or development and industry nearby may impact on the water table so much that the wetland dries out. Mining is one such activity that will disturb the water table and destroy wetland areas (Yilma, 2003).

Another serious threat to wetlands from industry and development is pollution. As yet there is little control on industrial emissions in developing countries. Pollution from heavy industry, in the form of heavy metals and chemicals, will usually exceed a wetland’s capacity to filter out such pollutants and can do serious damage to life in the wetland and make the water unfit for use by communities in the area. Sewerage pollution will also become a problem if the input of sewerage exceeds a wetland’s capacity to filter it, and such pollution will quickly lead to euthrophication of any open water; alter the species structure of the vegetation and make the water unfit for use (Berhanu, 2003).

Over exploitation of any wetland resources mentioned above, such as over- gathering reeds for thatching, will lead to an imbalance in the wetland ecosystem and may change its structure and species composition permanently. The complete drainage of wetlands for agriculture has lead to a number of ecological and economic problems. These include a scarcity of thatching reeds, change in the vegetation composition, lowered water tables and an accompanying reduction in agricultural productivity in the cultivated wetlands which may eventually lead to reduced overall availability of land for crop production.

2.5. The use of different assemblage.

Macro-invertebrates are an important component of stream and river systems and play crucial roles in maintaining the structural and functional integrity of freshwater ecosystems (Wallace & Webster 1996).They alter the geophysical condition of sediments, promote detritus decomposition and nutrient cycling, and facilitate energy transfer among tropic levels (Vanni 2002, Covich*et al*, 2004). Benthic macroinvertebrates are the most commonly used biological indicators in most aquatic ecosystems due to their variable sensitivity to environmental change (Pignata*et al*, 2013) and ease of sampling (i.e. low cost).Unfortunately, recent discoveries have shown extinction rates of freshwater fauna to be as much as 5 times greater than that of terrestrial fauna (Ricciardi& Rasmussen,1999).

The decline of benthic macro invertebrates in aquatic systems is largely due to anthropogenic impact in the form of habitat deterioration and nutrient overload. The diversity of the benthic community is progressively simplified due to the decreased number of taxa (Yuan 2010, Cai*et al*, 2012b). Habitat complexity is one of the key environmental factors influencing macro invertebrate communities. Complex habitats provide more ecological niches, which make macro invertebrates highly vulnerable to the loss of their preferred habitat (McGoff*et al*, 2013).

Consequently, habitat deterioration will severely depress the diversity and composition of benthic communities. Thus, identifying the possible factors regulating macro invertebrate structure, diversity and distribution can aid the development of more prescriptive conservation and management strategies for freshwater ecosystems in highly developed regions.

2.6. Biomonitoring

Bio monitoring is generally defined as the systematic use of living organisms or their responses to determine the condition of an environment. It is a method of observing the impact of external factors on ecosystems and their development over a period (Lil et al., 2010) or it is an ecological exercise where various kinds of biota are considered in determining the extent of pollution in a water body(Ma and Sharma, 2010).

Biological monitoring based on various aquatic biota may be more effective than measuring water chemistry alone, because the organisms integrate the chemical and physical properties of streams over time (Yung-Chul Jun, 2012).

Biomonitoring techniques are best used for detecting aquatic life impairments and assessing their relative severity (Barbour *et al,* 1999). Once impairment is detected, additional ecological data such as chemical and biological testing is helpful to identify the causative agent, its source, and to implement appropriate mitigation. Integrating information from these data types as well as from habitat assessments, hydrological investigations, and knowledge of land use is helpful to provide a comprehensive diagnostic assessment of impacts from different principal factors for description of water quality, habitat structure, energy source, flow regime, and biotic interaction factors (Barbour*et, al* 1999).

Bioindicators react both to long-term and sudden change of several environmental conditions (Baldwin et al, 2005). An ideal indicator at least should have taxonomic soundness (easy to be recognized by non-specialist); wide distribution; low mobility (local indication); well-known ecological characteristics; numerical abundance; suitability for laboratory experiments; high sensitivity to environmental stressors; and high ability for quantification and standardization (LiL, *et al*, 2010).

Different species respond in different ways and to different stressors. Thus, the presence of multiple stressors necessitates the use of multiple indicator species. A commonly used biotic indicator is community structure. This measures the response of the animal orplant assemblage at a site to environmental stressors. Measures of community structure include tax richness, diversity, relative abundance dominance and biomass. Measures of community ecosystem function include primary and secondary production, decomposition rates and nutrient cycling.

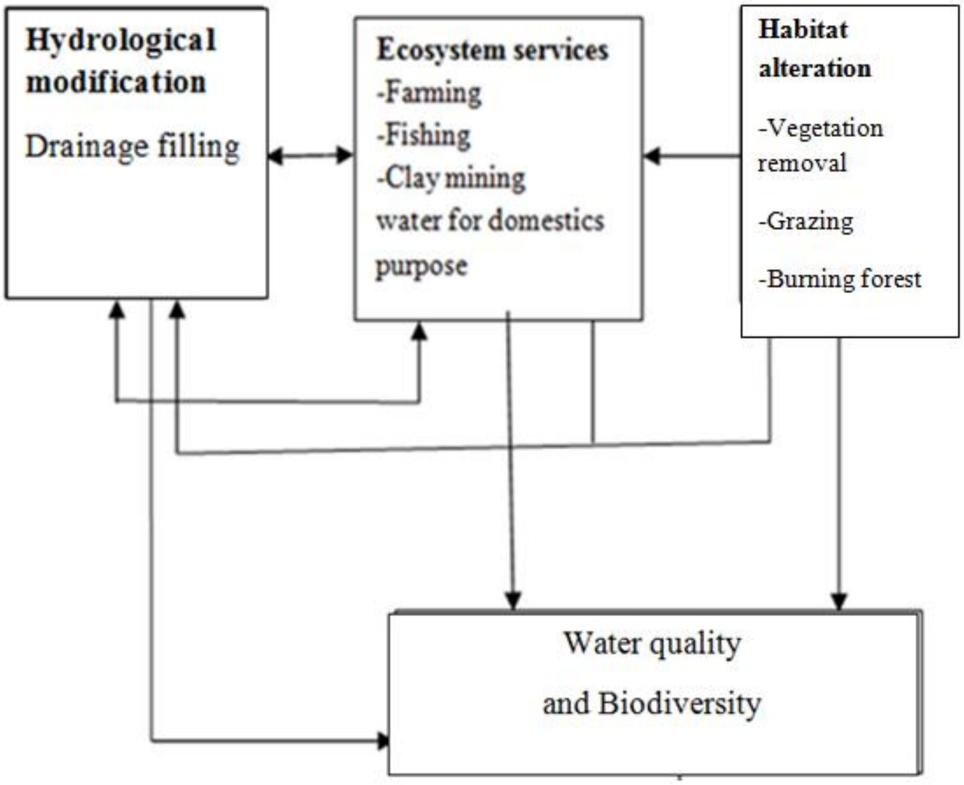


Figure 1. Conceptual frame work

CHAPTER THREE: OBJECTIVE

3.1. General objective

The main objective of this study was to assess the ecosystem services and identification the physicochemical and biological characteristics of Korok, Amodojoto, Boboand Akidi wetlands in Gambella region.

3.2. Specific objective

- To assess the ecosystem services on Korok, Amodojodo, Bobo and Akidiwetlands provided to the surrounding communities.
- To characterize the water quality of Korok, Amodojodo, Boboand Akidi wetlands.
- To identify macroinvertebrate and birds diversity of Korok, Amodojodo, Bobo and Akidi wetlands.

CHAPTER FOUR: MATERIALS AND METHODS

4.1. Study area

Korok, Amodojodo,Bobo and Akidiwetlands were located Gambellaregion Abolwereda. This region is located to the south west of the country at 766 kms away from Addis Ababa bordering the Oromiya National Regional State in the North.

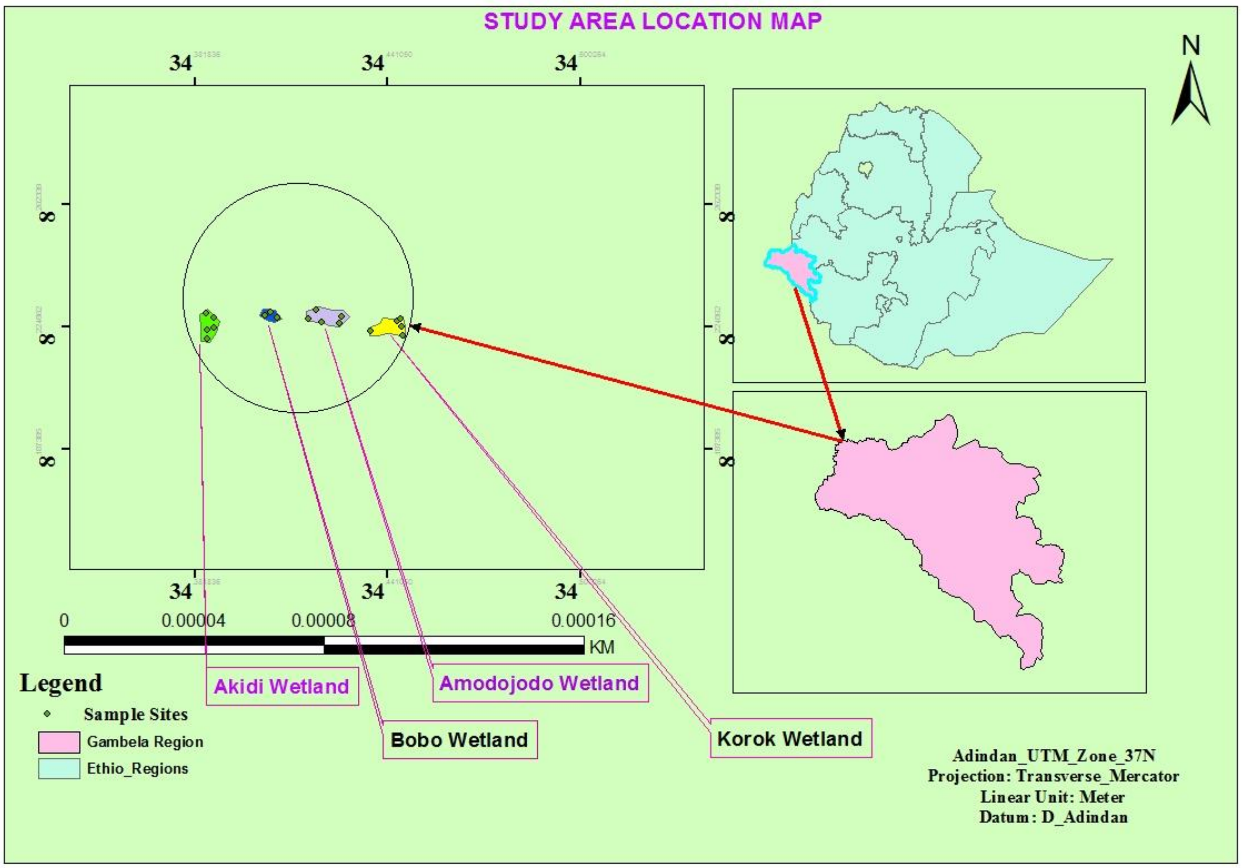


Figure 2.Map of study area showing map of Gambella Region and location of the four wetlands.

4.2. Study Design and period

A cross-sectional study was conducted on the wetlands of Gambella region.

Samples were collected during dry season near to the rainy season 2017.

4.3. The socio cultural characteristics

Abolweredahas 13 kebeles and 26 wetlands. Many of the kebeles are livingon Baroriver. The community are cultivating on agricultural, cattle and fishing. The communities are cultivating their crop production two times per a year downstream, especially maize but during dry season they are cultivating their crop production and vegetable downstream of the wetlands.

4.4. Wetlands selection

Among many, four wetlands were chosen mainly based on their accessibility and proximity to the community to assess their ecosystem services providing tothe surrounding communities. The two wetlands (Korok and Amodojoro) are known to serve the surrounding community with different services mainly as they are closely surrounded by community (human), while Bobo and Akidi are a bit far (approximately 7 km) from the community which is anticipated to have lesser ecosystem services to the community. Both wetlands are permanent wetlands with swamps expected to be abundant in wetland fauna and flora.

4.5. Community data collection

To understand the type of ecosystem services, focus group discussions (FGDs) were made. The ecosystem services obtained by the local community, threats posed to the wetland, and sustainability activities made by the communities were assessed. Those users who are more dependent use on the wetlands than others were identified for FGD based on their activities in the wetland resources (Mandondo, 1997). FGD was conducted separately in three groups: males, females and youth each having 8 to 12 members' participants. In total six FGDs were made from both groups. Appropriate time and comfortable place was selected and organized for FGD and before conducting discussion, explanation and elaboration of the need to do the FGD was made and participants were asked for consent. Each FGD group was conducted by three team member (not taker, recorder and facilitators). The FGD discussion were conducted and lasted for 1.5-2 hours. Discussion guides were used to undertake the FGD. When information is saturated (when participants do not have further discussions or start to repeat what they already said) the FGD session ends.

Discussionpoints were:

- ✓ . Do you use any wetland to support yourself and your family for any activity?
- ✓ Are there any dangers that could affect the wetland?
- ✓ What shall be done to be outer?

- ✓ What is your contribution to sustain the wetland?
- ✓ Describe the major direct drivers of the changes in the wetland?

Figure 3. Picture of male FGD participants in GnikwoKebeleAbolworeda, Gambela region.

Figure 4. Picture of female FGD participants in GnikwoKebeleAbolworeda, Gambela region.

Figure 5. Picture of youth FGD participants in GnikwoKebeleAbolworeda, Gambela region.

4.6. Site selection and sampling frequency

Water, aquatic macro invertebrate and birds samples were collected from 18 representative sites in fourwetlands of Gambella region area which include: Korok (5 sites), Amodojodo (5 sites),Akidi (5 sites) and Bobo (3 sites) wetlands. The number of sampling sites was uniformly distributed throughout the wetlands bases on their size, with the smallest wetlandhaving a lower number of sitesand the representativeness, existing information, and distance between sampling points over 100 meter reach was considered.

4.7. Water sampling

The method of measuring dissolved oxygen, electrical conductivity, water temperature and pH were conducted at each sites in the field and analyzed by using HACH multi hand-held probe, model HQ40D. Physical variables such as sludge depth and water depth were measured on sites. Water samples were collected with a two litter's plastic container from each 18 sites and then the samples were stored in a refrigerator at $4\,^{o}$C. All samples were transport from Gambella to Jimma University Environmental Health Science Laboratory in the insulated box containing ice packs. In the lab the samples were analyzed for total nitrogen, phosphate, total suspended solid total hardness and ammonia concentration according to the standard procedures placed for each parameter by (APHA, 1995).

4.8.Macro invertebrate sampling

Benthic Macroinvertebrates were sampled using a D-shaped sweep net using a rectangular frame net (20×30 cm) ; with mesh size of 300 µm and collected systematically from in water habitats by kicking the substrate for 5 minutes over 10 meter distance; to dislodge macroinvertebrates attached to any substrates present (Barbour et al 1999; Collected organisms were removed from the sweep-net and the net's content was washed into a sieve to collect organisms attached to the net; then stored in a bottle and preserved in 90% ethanol to be transported to Jimma University Environmental Health Science Laboratory. Aquatic taxonomic keys developed byProvonsha, 1983; Gerber and Gabriel, 2002; Richoux, 2002; Bounchard, 2004 and Oscoz, 2011)were used to identify specimens at family level using a stereomicroscope (10× magnification).

Figure 6. Pictures are indicated that kicking and collecting of macroinvertebrate in to the vial.

Figure 7.Picture of identification of macroinvertebrate in the laboratory.

4.9. Macroinvertebrate Metrics

A. Family Abundance and Richness

Abundance is the total number of individuals counted in a sample or a study site. It can be also used to express the abundance of sensitive taxa in a sample, for example: Ephemeroptera, Odonataabundance; and tolerant taxa such as Dipteran richness.

Taxa richness expresses the number of distinct taxa in a sample or a study site and represents the diversity within a sample (Barbour et al., 1999).

B. Shannon Diversity Index

This index is calculated as: $H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right)\ln\left(\frac{ni}{N}\right)$

ni- is the number of individuals in the i the species

N- equals the total number of individuals in the sample,

s- equals the total number of species in the sample

This index frequently varies from 0 to 5; as the number and distribution of taxa (biotic diversity) within the community increases, so does the value of H(Mandaville, 2002).C. Family Level Biotic Index (FBI)

Family Biotic Index summarizes the overall pollution tolerances of the taxa collected (Hilsenhoff, 2011). Individual families are assigned a tolerance score from 0 to 10 based on literature which was used to calculate FBI value at each site (Hilsenhoff, 1988) FBI can be calculated as:

FBI = $\sum \frac{xi\ ti}{n}$ where; "$\mathbf{x_i}$" is the number of individuals in the **"$\mathbf{i^{th}}$"** taxon, "$\mathbf{t_i}$" is the tolerance value of the **"$\mathbf{i^{th}}$"** taxon, and "**n**" is the total number of organisms in the sample.

Table 1.Categories of Water quality based on family biotic index (Hilsenhoff, 1988).

	FBI	
Family biotic index	Water quality	Degree of organic pollution
0.0-3.75	Excellent	No apparent organic pollution
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution
5.01-5.75	Fair	Fairly significant organic pollution
5.76-6.50	Fair poor	Significant organic pollution
6.51-7.25	Poor	Very significant organic pollution
7.26-10.00	Very poor	Severe organic pollution

Biological Monitoring Working Party (BMWP)

The BMWP score is calculated by adding the individual scores of all indicator organisms present at family level. The organisms are identified to the family level and then each family was allocated a score between 1 and 10 based on literature. Then the BMWP index value was calculated for each sampling site. The score each family gets reflects their perceived susceptibility to pollution, which is based on the principle that different aquatic invertebrates have different tolerances to pollutants(Paisley et al., 2004). For example, mayfly and stonefly families are not very tolerant of pollution, so these families are given a score of 10. The presence of these high scoring families indicates a site with unpolluted water. The lowest scoring invertebrates are worms which score 1, as they are much more tolerant of pollution. They can tolerate heavily polluted waterways but are still found in unpolluted conditions as well. The overall BMWP Score for a site is the sum of all of the scores of each family present at that site (Zeybek et al., 2014).

Table 2.Categories of water quality using BMWP Score (Mandeville, 2002)

BMWP	Category	Interpretation
0-10	Very poor	Heavily polluted
11=40	Poor	Polluted or Impact
41-70	Moderate	Moderately Impacted
71-100	Good	Slightly Impacted
>100	Very good	Unpolluted

4.10. Birds identification

The method of counting population total number of birds was conducted(USEPA, 2002). The representative of birds species at each sampling sites were identified and counting in this method used field binoculars and physical feature with the help of field guides reference books on the bird fauna of Each Africa (Perlo, 2009) and after finished the data was writing in to excel.

4.11. Study variable

Ecosystem services, water quality, TSS, total hardness, Ammonia, Phosphate, Chloride, pH,DO, EC, Water temperature, Water depth andSludge depth,Macroinvertebrate assemblages and birds diversity.

4.12. Ethical consideration

Ethical clearance were taken from Ethical and Research Committee of Jimma University, College of Health Sciences to officially ascertain that the research was relevant and approved by the college as well as by the Department of Environmental Health Science and Technology.

4.13. Dissemination plan

The final result of this study will be presented to Jimma University, College of Health sciences, Department of Environmental Health Science and Technology. Endeavors will be made to publish the paper in international review journal.

4.14. Data quality control (Pretest)

To ensure the quality of data controlling checklist of focus group discussion (FGD) was prepared base on the ecosystem services, sustainability of the wetlands and threats posed to wetlands made by the community and directing changing on the wetlands. The English version was translated into local language to avoid bias and make clear the message of the main point. Correcting data was checking for completeness and clarify correction make tools and finally the data was checked for completeness before analysis.

To ensure a high level of consistency and accuracy in all operations in the field measurements, sample collection and field processing. A standard procedure method and protocol was followed. Laboratory and field instruments were calibrated and standardized. For the water samples transportation was maintained keeping the samples in the cold box.Reidentificationofmacroinvertebrate.Data entry was performed carefully to assure the quality.

4.15.Data analysis

Qualitative data analysis, data from FGD was transcribed, coded, categorized and schematized, manually to identify the ecosystem services and associate it with the water quality and diversity of birds and macro invertebrates.Laboratory data analysis, principal component analysis (PCA) biplot based on a correlation matrix among samples was used to analyze the physicochemical data, macroinvertebrate and birds PCA was performed using PAST software (Hammer *et al* 2001).

CHAPTER FIVE: RESULTS

5.1. Ecosystem services: from the community perspective.

From the six FGDs it was possible to figure out the major ecosystem services provided by the wetlands to thesurrounding community. From the four wetlands, Korok and Amodojodoprovided the services for the communitiesas raised by all groups which encompass crop production (maize),vegetable(tomato), fishing, cattle grazing, domestic purposesand raw materials (such as thatching grass, medicinal plants and firewood) during dry season. These two wetlands were much closer to the communities. Discussants explained that during summer season,Baro river flow out and drained into both wetlands which made the wetland to providea number of ecosystem services to the surrounding communities. However, the FGD participants mentioned that Boboand Akidi wetlands were not giving services to the communities because they were very far distance (approximately 7 km)unlikeKorok and Amodojodo, which is about 2km far. As the result the nearest wetlands are giving much of the ecosystem services to the local community.Most of the ecosystem serviced mentioned by the FGD participants are explained in table 3.

Table 3: Importanceof ecosystem services providing the wetlands to the communities listed by the FGDparticipants

Ecosystem services	Korok	Amwodojodo	Bobo	Akidi
Crop production	✓	✓		
Fishing	✓	✓		
Grass cutting	✓	✓	✓	✓
Plants for fire wood	✓	✓		
Pottery	✓	✓		
Medicinal plant harvesting	✓	✓		
Water for domestics	✓	✓		
Grazing (locals and nomads)	✓	✓	✓	✓
Cultural service	✓	✓		
Drinking water for human	✓	✓		
Domestics animal and wildlife animal water drinking	✓	✓		

5.2. Wetland threats

The dangers of wetlandswere over grazing (local and nomads from Sudan), over fishing, burning forest, over exploitation of the grass resources, deforestation and water erosion.

Table 4.Dangersof wetlands listed by the FGDparticipants made by the communities.

Danger for wetland	Korok	Amodojodo	Bobo	Akidi
Over grazing (locals and nomads)	✓	✓	✓	✓
Over exploitation of the grass resources	✓	✓		
Over fishing	✓	✓		
Burning forest	✓	✓	✓	✓
Deforestation	✓	✓		
Water erosion	✓	✓		

Overgrazing, over fishing, over exploitation of the grass resources, burning forest, deforestation, should be minimizing to maintain and protect wetlandsecosystem services. Communitiesmade canal from Baroriverto the wetlands of Korok and Amodojodo.Occurrence of drought was a major direct driverchange in the four wetlands

5.3. Water quality

Physicochemical results analysis of Korok(K1,K2,K3,K4 and K5),Amodojodo (A1, A2, A3, A4 and A5), Bobo (B1,B2 and B3) and Akidi (Ak1,Ak2,Ak3,Ak4 and Ak5) wetlands at each 18 sampling sites. The water temperature ranged from 25 to 36 °C, water depth 0.33 to 2.1, and sludge depth 0.15 to 0.60, electronic conductivity µS/cm 36.7 to159,pH 6.6 to 8.73 andDO 6.52 to 11.95.

In table 5.Korok and Amodojodo wetlands, the average of TN, pH, TSS,EC,sludge depth total hardness, phosphate, water temperatureand ammonia were very high. Theaverage ofWater depth and DO were very high in Bobo and Akidi wetlands.

Table 5.Physicochemical, water quality of Gambella region Abolwereda in the studyarea of the four wetlands: mean values and standard deviation.

Environmental variable	Unit	Korok		Amodojodo		Bobo		Akidi	
		Mean	StDev	Mean	StDev	Mean	StDev	Mean	St.Dev
TN	mg/L	33.7	27.7	45	29.5	10.34	4.18	19.8	13.41
Phosphate	mg/L	0.67	0.09	0.70	0.17	0.42	0.1	0.57	0.29
TSS	mg/L	93.8	96.5	171	124.5	11.06	3.86	31.56	35.7
Ammonia	mg/L	0.11	0.0027	0.11	0.004	0.11	0.005	0.11	0.001
TH	mg/L	164	32.86	128	30.33	44	5.29	65.6	51.83
Chloride	mg/L	7.51	7	7.51	7	3.65	1.1	6.27	0.83
DO	mg/L	8.62	0.79	7.9	1.7	10.50	0.80	10.9	0.81
pH	mg/L	8.18	0.67	7.30	0.43	7.29	0.45	6.69	0.093
EC	µs/cm	138	23.44	103.7	39.19	43.06	6.72	47.7	4.61
Water T^{O}	^{O}C	32.2	1.99	31.1	5.39	30.1	1.21	27.5	0.95
Water depth	CM	0.72	0.37	0.8	0.21	1.00	0.5	1.26	0.24
Sludge depth	CM	0.73	0.1	0.37	0.1	0.29	0.13	0.23	0.06

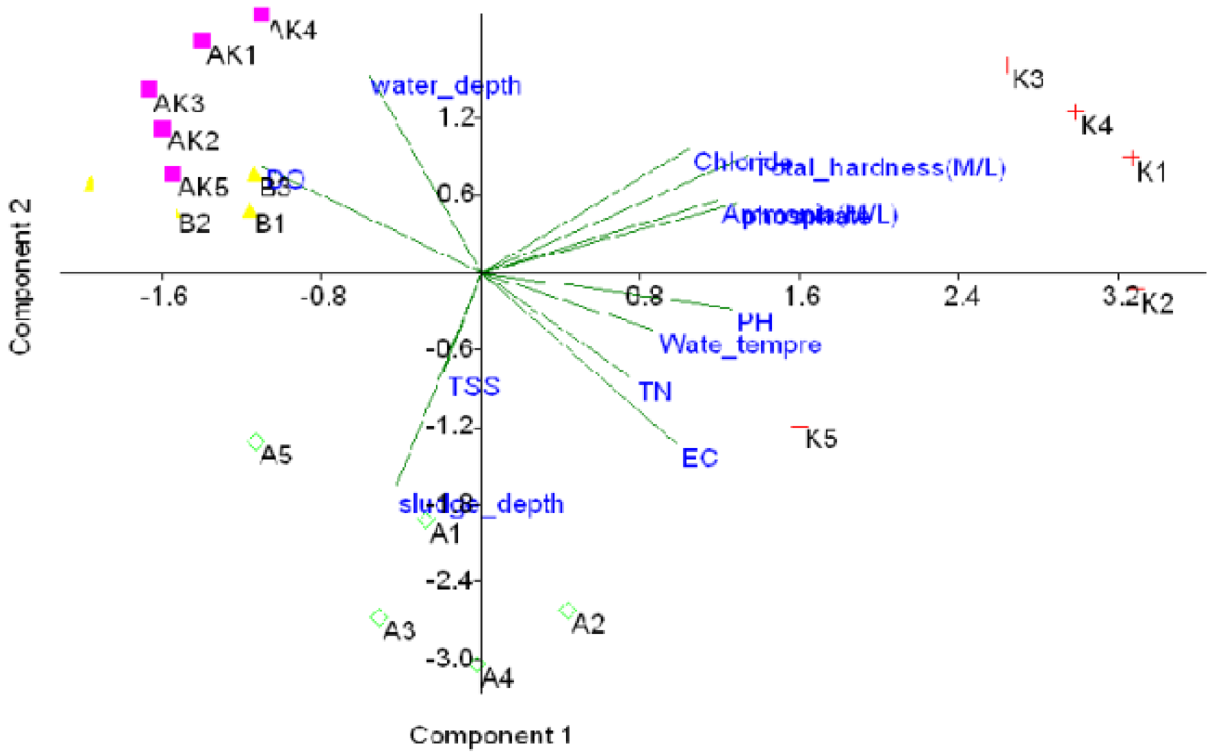


Figure 8.PCAbiploteof the physicochemical characteristics among different sites of the wetlands (component 1 and 2 have 28% and 22% variability respectively.

Results of the PCA performed on the matrix of physicochemical parameters where showed in the figures. The main contributors of the firstcomponent 1 and 2, group 1 in the figure at sites (A1, A2, A3, A4, A5,) were dominated by TSS , sludge depth and EC, group 2 at sites (K1,K2,K3, K4 and K5) were dominated by, chloride, total hardness, ammonia, phosphate,water temperature, pH, TN, andgroup 3at sites (AK1, AK2 AK,3 AK4, AK5, B1, B2 and B3)were dominated by water depth and DO.

5.4. Macro invertebrate assemblages

From wetlands of Korok, Amodojodo, Bobo and Akidi, the total collected of macroinvertebrates were1563 from each 18 sample site and macroinvertebrates were classified in to 8 orders and 21 families. From 8 orders the most abundant of macroinvertebrates were corixidae and dytiscidae which are counted for 755 (47.9%) and 592 (37.5%) respectively while the most abundant order were Coleoptera and hemiptera and they counted 793(50%). These two orders were represented by 7 families and found at about 94.4% of sampling sites.

The highestfamily of richness was 10 which were represented at site Ak4 (426)and the least family richness were 3 which wererecorded at sitesA 4 (9). Index of macroinvertebrate communities was significantly lower at 8 sites (K1, K4, K5, A2, A3, A4, B2 and B3) having less than 1 index; however, 10 sites were showed 1-3 index. The EO family richness were found at 11 sites (K1, K2, K3, K4, A4, B1, B3, AK1, AK3, AK4 and AK5)and there were no EOfamily at some sites(K5, A1, A2, A3, B2 and AK2). Dipteran family wasfound only at sites (A1, A2, A5, AK2 and AK5)and not found at sites(B2, B3, AK1, AK3, and AK4)in the table below.

Table 6.Shannon Diversityindex ofmacroinvertebrate assemblages in Gambellaregionwetlands.

Sites	Abundance	Family Richness	EO Family Richness	Dipteran Family Richness	Shannon Diversity Index
K1	45	7	3	0	1.76
K2	62	8	3	0	0.99
K3	36	8	3	0	1.15
K4	22	4	1	0	0.82
K5	209	3	0	0	0.11
A1	21	4	0	1	1.06
A2	10	5	0	1	0.18
A3	76	4	0	0	0.96
A4	9	6	2	0	1.89
A5	9	3	1	1	1.55
B1	222	5	1	1	1.62
B2	15	6	0	0	0.99
B3	13	6	1	0	0.83
AK1	29	8	1	0	1.7
AK2	33	7	1	1	1.62
AK3	242	6	1	0	0.5
AK4	426	10	2	0	1.98

AK5	84	5	2	1	1.34

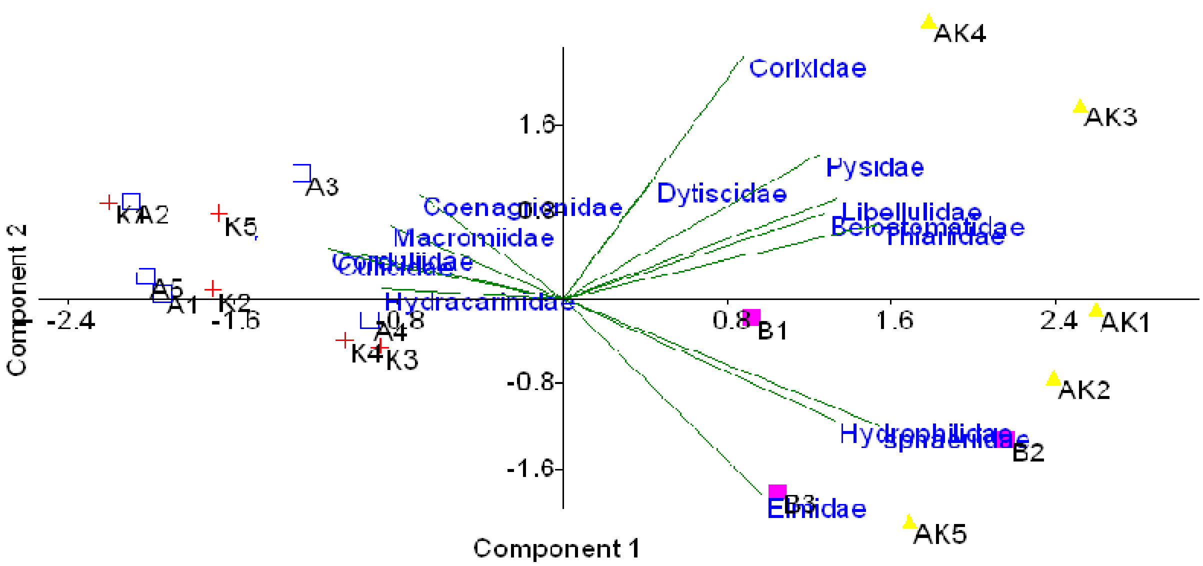
According to BMWP indicated onlyat 4 sites (K1, K2, K3, and AK4) were comprised of moderate water quality and the rest sites were poor water quality. The FBI values differed considerably among the 18 sampling sites. From each sample sites of Korok and Amodojodo wetlands excellent was observed only at 2 sites (K5 and A3) and the rest sitesfairly poor and very poor were observed, but Bobo and Akidi wetlands sites excellent was observed at most sites (B1, AK3, AK4 and AK5) and the rest were friar and very poor were observed.

Water quality category based on BMWP Score and FBI of the different study sites area of Gambella wetlands of Korok, Amodojodo,Bobo and Akidi.

Table 7.Water quality category based on BMWP Score and FBI of the different study sites of biological working party (BMWP).

Sites	**BMWP**	**Water quality class**	**FBI**	**Water quality class**
K1	41	Moderate	7.7	Very poor
K2	49	Moderate	6.6	Fairly poor
K3	49	Moderate	12.4	Very poor
K4	23	Poor	5.9	Fairly poor
K5	15	Poor	0.34	Excellent
A1	17	Poor	6	Poor
A2	22	Poor	18.5	Very poor
A3	20	Poor	1.68	Excellent

A4	32	Poor	21	Very poor
A5	12	Poor	6.6	Very poor
B1	25	Poor	0.87	Excellent
B2	21	Poor	4	Very good
B3	22	Poor	16	Very poor
AK1	32	Poor	15	Very poor
AK2	27	Poor	9.54	Very poor
AK3	22	Poor	1.13	Excellent
AK4	46	Moderate	1.68	Excellent
AK5	28	Poor	2.12	Excellent



In the PCA biplot figure 9 component1at sites (AK1, AK2, AK3, AK4, AK5, B1, B2 and B3) were dominated by corixidea, dytiscisdaee, belostomatidae,hydrophlidae, elmidae, pysidae,spaeridae, thiariidae and libelullidae, component 2 at sites (K1,K2, K3, K4, K5, A1, A2, A3, A4andA5) were dominated by macromiidae, cordullidae, cullicidae, hydracarinidae and coenagrionidae.

Figure 9.PCA biplotof macroinvertebrate communities among different sites of the wetlanu8ds (component 1 and 2 have 28 and 21.3 % variability respectively).

5.5. Birds metrics

The recorded total number of birds was 416 and represented by 9 species. The most abundant taxa of birds species were cattle-egret 102(24.93) %African jacana 70(17.1) %and pink backed pelican 64(15.64%). Cattle egret species were found at sites (B2, B3, Ak1, Ak2, AK3, AK4, AK5, K1, K2, K5, A2, A3), African jacana found at (K1, K2, K3, A3, B1,Ak1 and Ak2), pink-back pelican found at sites (B2, B3, Ak1, Ak2, AK3, AK4 and AK5)Goliain Heron and Senegal-Coucal were found at sites (K1, K2, K3, K4, K5,A1, A2, A3, A4, A5 and B1).The highest species richness were 6 which were represented at sites (AK4) followed to 5 which represented at sites Ak2 and the least species richness were observed at sites (K5, A4 and A5) having only 1. Shannon diversity index of birds communities was significantly lower at 7 sites (K4, K5, A1, A2, A4, A5 and B3) having less than 1 index and not observed at sites (A4 and A5) however, 11 sites showed 1-3 index were (K1,K2,K3,A3,B1, B2, Ak1,AK2,AK4 and AK5).

Table 8.Birdsmetric richness and diversity abundance.

Birds

Sites	Diversity Abundance	Species Richness	Shannon Diversity Index
K1	37	4	1.35
K2	22	4	1.24
K3	10	2	1.05
K4	16	2	0.61
K5	4	1	0.5
A1	15	2	0.89
A2	27	4	0.53
A3	7	2	1.03
A4	5	1	0
A5	1	1	0
B1	7	2	1.03
B2	17	4	1.1
B3	11	2	0.56
AK1	61	3	1.56
AK2	75	6	1.25
AK3	32	4	1.32
AK4	50	7	1.19
AK5	19	4	1.16

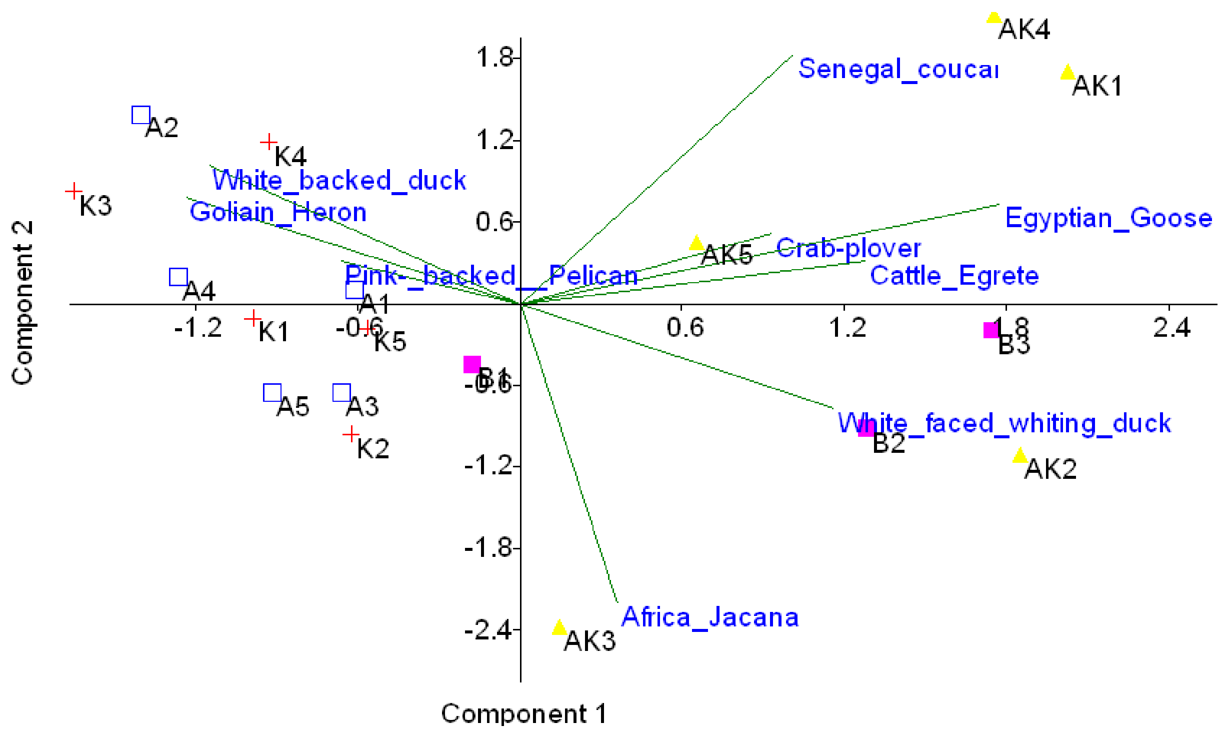


Figure 10.PCA biplotof birds communities among different sites of wetlands

From the PCA figure 10a component 1 explains 29.5% variationandcomponent 2explain 22.9% variation among different sites. In the figure 10 component 1 and 2 group 1 at sites (K1,K2, K3, K4, K5, A1, A2, A3, A4, A5 and B1) were dominated by Goliain Heron, Senegal-Coucal and, Pink-Backed Pelican Group 2 at sites (B2, B3, AK1,AK2, AK3, AK4, AK1) were dominated by African Jacana , White face-Whiting duck, Egyptian- Goose, Cattle-Egrete and Crab-plover.

CHAPTER SIX: DISCUSSION

6.1. Discussion

The ability of wetlands to store water during the wet season and release it during the dry season provides farmers living in semiarid areas opportunities to grow crops all year, thereby improvingfood security and incomes(Matiza and Chabwela, 1992;Getachew*et, et al.*, 2012).Besides crop production, wetlands also provide other services that support human welfare such as livestock grazing and watering, water supply, and fishing.This is the same in the present study, Korok and Amodojodowetlands as reported by FGD participants both wetlandsare providing higherecosystem services to the surrounding communities, may be due to that the wetlands water quality become poor, muddy, macroinvertebrateand birds diversity were very lower comparing to the Bobo and Akidi wetlands.Piguet(2002) also reported that discussants recognized that the wetland is increasingly threatened by uncontrolled resource use and indicated that impacts onthewetlands.

Communities made the canal from Baroriverto the wetlands of Korok and Amodojodoto protect both wetlands from drying during dry season and proceeding giving ecosystem services to the surrounding communities.

Climate change was the major direct drivers of the changes in the wetlands, beforefive year ago due to the representative of the climate change, made thefour wetlands dry during dry season.Tilahun*et al*. (2011) also reported that climate change, one of the most complex current environmental issues, primarily affects Ethiopia via the global and local degradation of vegetation.

In Gambella region wetlands of Korok, Amodojodo,Bobo and Akidi water quality, macro invertebrate diversity and bird’s habitat conditions were affected by ecosystem services (human activities). In figure 8 of the PCA ,the main contributors, in relation to component 1Korok and Amodojodosites were grouped togetherand having loading much nutrient, most probably due to the represented of frequentlyhigher ecosystem services in both wetlands provided to the surrounding communities.Agreement with pH values of surface water which lie within the range of 6.5 to 8.5 (WHO), Geneva (2004) but in the present study the highest values of pH were recorded at sitesK1(8.73) and K5 (8.64)thus were above the recommended guide line and it might be due to the present of higher ecosystem services in the wetlands provided to the surrounding communities.Gopalkrusna(2011) also reported that nutrient occurs in water from various natural resources and due to human activities like food production, agriculture runoff containing fertilizer and manure disposal of domesticwaste.

In relation to component 2in figure 8 at sites of Bobo and Akidi wetlands, were also grouped together and loading DO and water depth, most probably dueto the absent ofhigher ecosystem services provided to the surrounding communities (human activities). Gupalkrushna (2011)also reported that DO value indicates the degree of pollution in the water bodies. Color reduces the use fullness of water.In the present of study the range of DO is (6.52-11.95)(A5 and AK4) (Francis and Floyd, 2003) reported that DO level falls undesirable changes in odor, taste and color.

In the above table 6wetlands of Korok, Amodojodo, Bobo and Akidi,the lower Shannon diversity index than 1 ofmacroinvertebratecommunities at most sites of Korok and Amodojodowetlands, having least family richness,having some number of Dipterans family at some site and having lowerobserved EO family at few site in table 6respectively, thusmight be indicated that most probably due to the present of higher ecosystem services providing to the surrounding communities (human disturbances), loading nutrients, lower DO orthe number of sensitive taxa become limited due to their lower moderate pollution.Selvanayagam&Abril,(2016) also reported that the presence of Dipterans larvae is the indicator of organic pollution.

Despite higher abundance of macroinvertebrate, representativesensitive taxa (EO) at most sites,higher Shannon diversity index 1 to 3 and having lower Dipterans family this might be most probably due to the absent of higher ecosystem services provided to the communities ordaily human activities and the represented of higher DO and water depth. Ephemeroptera and odonata comprise a group of organisms highly sensitive to pollution, requiring clean and well having less than 1 index oxygenated waters for their survival. Souto et al, (2011) also reported thatthus, the occurrence of these taxa is an indication of good water quality.

Hilsenhoff FBI and BMWP indices were used to assess the organic pollution status of the wetlands using families of macroinvertebrate assemblages and the results were inabove the table7. According to BMWP indicatedof Korok, Amodojodo, Bobo and Akidiwetlandsonly at4 sites were moderately impact and the most sites were showed polluted or impacted and why the source of this organic pollution most probably do to organic matter/pollution coming from human activities, domestics waste releasing, cattle waste releasing, wildlife animals waste releasing or vegetation break down (litter decomposition). Getachew et al. (2011) also reported that the nutrients and organic materials as a result of human activities associated with agriculture, deforestation and waste dumping are the major causes of water quality deterioration in wetlands.

In relation to component 1 in the PCA biplot figure 9Bobo and Akidi sites were grouped together and loading many species of macroinvertebrate, most probably due to the absent of higher ecosystem serviceproviding to the surrounding communities or the representativeof higher DO and water depth . DO levels are an indicator of a water body's ability to support aquatic life. According to U.S Environmental Protection Agency, and Alakanda et al, (2011) O > 5 mg/l is considered favorable for growth and activity of most aquatic life; In the present study at sites of Bobo and Akidi wetlands DO were range from 8.59 -11.95. In relation to component 2in the PCA biplotfigure 9Korok and Amodojodo sites were grouped together and having least loading of macroinvertebrate, most probably due to the present of higher ecosystem services provided by both wetlands of Korok and Amodojodoto the surrounding communities (daily human activities) or theabsent of higher DO and representative of loading much nutrient.McGoff et al. (2013) also reported that consequently, habitat deterioration will severely depress the diversity and composition of benthic communities, Tank and Chippa, (2013) also reported that the aquatic life distressed when DO levels drops to 4-2 mg/lit.

In table 8at most sites of Korok and Amodjodowetlands the recorded number of birds diversity were least,the least species richness and the having lowerShannon index diversity than 1 at most sites of Korok and Amodojodo, most probably due to the present of higher ecosystem services provided to the surrounding communities.

The number of birds diversity recorded at Boboand Akidi wetlands sites in the tablewere high and Shannon index showed 1-3 indexat most sites, this most probability due to the absent of higher ecosystem services provided to the surrounding communities or human activities.Thomas et al. (2003) and Blanc et al. (2006) also reported that human disturbance negatively impacted water birds by reducing their feeding times.

In the PCAfigure10related to the component 1 the sites of Bobo and Akidi wetlands were grouped together and loading many species, this most probably due to the absentof higher ecosystem services provided by both wetlands to the communities and the present of higher water depth and DO.

In relation to component2 at sites Korok and Amodojodo wetlands were grouped together most probably due to the present of higher ecosystem services provided by both wetlands to the surrounding communities or (human activities). Razafimanjato et al. (2007)also reported that decline in the number of water birds due to human disturbance.

CHAPTER SEVEN:CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

Farming was the main source of livelihood in local communities in the study wetlands. However, because most communities had their own small landholdings and large families, farming did not sufficiently meet the needs food of many communities, leading to overexploitation and conversion of wetlands to farmlands. In this study, Gambella wetlands of Korokand Amodojodo,were provided preliminary assessment of what appears to be predominantly of ecosystem services on water quality and macroinvertebrate and birds communities and the finding in this study, the result of physicochemical, indicate that the higher level of TN, pH, TSS, total hardness, EC, ammonia, chloride, phosphate, and water temperature, sludge depth and the lower, DO, water depth, abundance of macroinvertebrate diversity, birds diversity, family richness and Shannon diversity index in the wetlands of Korok and Amodojodo,it concluded that due to the representing of higher ecosystem services and the two wetland are characterize poor water quality. The representative of lower of TN, pH, TSS, total hardness, EC, ammonia, chloride, phosphate, water temperature, sludge depth and the representative of higher DO, water depth in Boboand Akidiwetlands, it concluded that due to the absent of higher dominating ecosystem services providing to the surrounding communities (Human activities), the two wetland are characterize good water quality.

7.2. Recommendations

According to this studythe resource ofKorok,Amodojodo,Bobo and Akidi wetlands in Gambella region of the study area are facing various ecosystem services activitiesand natural factors, which drive the wetlands to death. Therefore conservation of the four wetlands are needed from government to involve the local residents, policy maker, knowledgeable individual, (indigenous), NGOs and other stakeholder for Korok, Amodojodo, Bobo and Akidiwetlands sustainable and general public about how to use the resource of the wetlands and scientific significance of the resources of the four wetlands.

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Appendix

Annex1. Wetland sampling protocol

Wetland assessment

General information

DD/MM/YYY---Time-------------------

Name of wetland-------------------------------------Sampling station-------------------

Altitude (M) --------------------------------------coordinates------------------------------

Weather condition---

Previous day rain history--

Photo number--

Size of site under assessment (ha) --

Size of total wetland (ha) ---

-

Notes and or sketch of the site

Physico-Chemical parameters (Field)

Ambient Temperatures (^{0}c) --------------------------------pH-------------------------------------

-

Water temperature (^{0}c) ----------------------DO(mg/l)-------------------EC(µS/cm)------------

-

Turbidity (NTU) ------------------------------Transparency (cm) sechi depth ------------------

------

Chlorophyll a (µg/l) --------------------------------

Color---odor--

Physico-Chemical parameters (laboratory)

COD---NO_2---

NH_4---

TSS---TN---

BOD_5---TP--

NO_3--PO_4^{3-}--------------------------------------

Hydrological assessment

Wetland geographic setting ---

Reverine--

Depressional --

Meandering flood plain--

Other--

Site setting/degree of isolation from other wetland

The site is connected upstream and downstream with other wetland

The site is only connected upstream with other wetlands

The site is only connected downstream with other wetlands

Other wetlands are nearby (within 0.25 mile) but not connected

The wetland site is isolated

Free water depth (cm)

Minimum ----------------b. maximum---------------------- Average--------------------

Sludge depth

Minimum----------------b maximum----------------------Average--------------------

Soil type

Organic--

Mineral--

Both organic and mineral---

Apparent hydroperiod

Permanently flooded

Seasonally flooded

Saturated (surface water seldom present)

Artificially flooded

Artificially drained

Hydrological modified

Ditch inlet and outlet------------------------------ d. culverts ---------------------------------

Drainage--- e. filling or bulldozing-------------------

Storm water input----------------------------------   f. others specify--------------------------

Land use

Adjacent land use pattern

Agriculture tilled-------------   e. road-------------------

Pasture--------------------------   f. commercial---------------

Native vegetation-------------   g. industrial------------------

Residential area---------------   h. recreational---------------

Habitant assessment

Hydrophytic vegetation coverage (%)

Woody plants----------------------------   e. floating macrophytes-----------------------

Water grass-------------------------------   f. periphyton----------------------------------

Emerged macrophytes-------------------   g. filamentous algae--------------------------

Submerged macrophytes-----------------   h. other specify-------------------------------

Wetland fauna

Birds(ducks)------------------------------- c. invertebrates---------------------------------

Fish--- d. others--

Anthropogenic activities	wetland	upland
Cultivation	--	-----------------------------------
Tree removal	--	----------------------------------
Shrub removal	---	----------------------------------
Tree plantation	--	----------------------------------
Grazing	--	----------------------------------
Grass cutting	--	----------------------------------
Brick manufacture	---	----------------------------------

Car washing -- --------------------------------

Clay mining/pottery -------------------------------------- ------------------------------

Waste dumping -------------------------------------- ------------------------------

Fishing ------------------------------------- ------------------------------

Swimming -------------------------------------- ------------------------------

Other potential threats

Agricultural biocides--

Point source pollution--

Wetland ecological state

Unmodified, natural--

Largely natural with few modification--

Moderately modified--

Largely modified--

Seriously modified--

Critically/extremely modified---

Any additional comments --

Annex 2 physicochemical environmental variable and laboratory procedures for the physicochemical parameters

Sites	TN (mg/L)	PO_4 (mg/L)	TSS (mg/L)	NH4 (mg/L)	Total Hardness (mg/L) CaCO3	$Cl^{-(mg/L)}$	pH(mg/L)	DO mg/L	E.C (µS/cm)	Water T°(°C)	Water Depth(meter)	Sludge depth(m)
K1	81.9	0.77	13.3	0.119	200	19.99	8.73	8.35	158.8	30	0.95	0.60
K2	19.6	0.71	233	0.119	140	3.59	8.2	7.6	150	35.1	0.80	0.55
K3	15.1	0.69	13.3	0.121	140	3.99	7.05	8.68	156.7	32.5	0.33	0.90
K4	32.9	0.52	153.3	0.114	140	4.99	8.3	8.7	105.5	34	1.18	0.85
K5	19.4	0.7	56.6	0.116	200	4.99	8.64	9.78	123.2	31.6	0.35	0.75
A1	57.7	0.83	31.33	0.117	120	19.99	6.91	8.91	136.2	36	0.55	0.45
A2	87.8	0.78	198	0.117	160	4.99	7.89	6.67	118.9	35.3	0.75	0.45
A3	38.7	0.85	330	0.117	100	3.59	6.84	10.62	138.3	33.8	0.625	0.50
A4	32	0.43	60	0.117	160	4.99	7.42	6.95	50.6	25.6	0.85	0.225
A5	9.29	0.63	236	0.116	100	3.59	7.46	6.52	74.7	25	1.1	0.225
B1	13.6	0.53	13.3	0.11	46	4.99	7.11	10.42	50.1	29.9	0.5	0.22
B2	5.62	0.33	6.6	0.118	38	2.99	6.96	9.75	36.7	29	1.01	0.45
B3	11.8	0.41	13.3	0.12	48	2.99	7.82	11.35	42.4	31.4	1.5	0.22
Ak1	17.6	0.21	31.33	0.12	80	5.99	6.84	11.34	39.9	27	1.5	0.30
Ak2	39.5	0.73	93.3	0.117	120	6.39	6.65	9.8	50.8	26.3	1.3	0.22
Ak3	24.9	0.53	13.3	0.117	50	6.99	6.65	10.9	49	27.4	1.	0.225
Ak4	3.73	0.42	6.6	0.117	30	4.99	6.73	11.95	51.3	27.9	1.5	0.15
Ak5	13.3	0.99	13.3	0.117	120	6.99	6.6	10.55	47.5	28.9	1.1	0.30

Total Hardness

EDTA Titrimetric Method

1. Measure the appropriate sample volume for the indicated hardness ranges and transfer to a 250 ml Erlenmeyer flask.

Sample volume mL.	Alkalinity range mg/Las $CaCO_3$
50	0- 300
25	301-600
10	601-1,500

2. If a sample volume of 25 or 10 ml is used, bring the total volume to 50 ml by adding distilled water.

3. Prepare a color comparison blank by placing distilled water in a similar flask and Which has the same volume as the sample used for analysis?

4. Add 1-2 ml of buffer solution to the color comparison blank and the sample and Mix.

5. Add 0.2g solid indicator mixture (Eriochrome Black T) to the color comparison blank and the sample. Mix to achieve dissolution

6. To the color comparison blank, carefully add from a burret one drop of EDTA titrant at a time unit the purplish color changes to a bright blue.

7. Record the mL EDTA consumed.

8. If the sample turns a red or purple color in step 5, gradually add EDTA titrant from a buret shaking the flask constantly. Stop the

titrant addition at this point for 10 seconds but continue the shaking (or stirring).

10. Resume adding the EDTA titrant drop by drop until the purple color turns to the Same bright blue color as in the color comparison blank. Shake the flask throughout the addition of the titrant.

9. Continue adding the titrant until the wine red color turns to a purplish tinge.

11. Record ml EDTA consumed.

12. Calculate the net volume of titrant used for the sample alone by subtracting the ml titrant consumed by the blank from the result found in step 11.

15. Calculation

Total hardness, as Mg/ $CaCO_3$/L = $\frac{(A-B) \times N \times 50{,}000}{\text{Ml of sample}}$

Where

A= Ml titration for sample

B= ML titration for Blank, and

N= Normality of the EDTA titrant

Note:

Complete the titration within 5 minutes, measured from the time of buffer Addition.

The absence of a sharp end- point color change in the titration usually Means that an inhibitor must be added at this point or that the indicator has Deteriorated.

AMMONIA NITROGEN

Ammonium chloride solution to a 50 mL volumetric flask stoppered graduated Cylinder and diluting to 50 mL with ammonia free distilled water.

Standard Ammonia Solution, Ml	Ammonia Nitrogen ug /50 mL

Direct Nesslerization Method

Prepare a series of standards by transferring the following amounts of standard

0	0
0.5	5.0
1.0	10.0
2.0	20.0
3.0	30.0
4.0	40.0
5.0	50.0

Nesslerize the standards by adding 1.0 mL Nessler's reagent to each flask with a

Safety pipet.

Stopper and invert several times

Read the absorbance 425 nm at least 10 minutes after adding Nessler's reagent

Plot a calibration curve absorbance versus concentration

Treatment of Samples

Take 100 mL of sample in a 100 mL volumetric flask or graduated cylinder

With a measuring pipet add 1 mL zinc surface solution and mix thoroughly

Add 0.4 to 0.5 mL 6N sodium hydroxide solution to obtain a PH of 10.5 and mix thoroughly.

Let treated sample stand for a few minutes, where upon a heavy flocculent precipitation should fall, leaving a clear and colorless super mate

Prepare a filter with a fast filter paper by washing it until it is free of ammonia (Check then filtrate with Nessler's reagent)

Pour estimated 25 mL of the clear liquid through the filter paper. Discard this filtrate.

Pour the remaining clear liquid through the same filter and catch the filtrate in a clean 100 mL stoppered graduated cylinder

Measure the appropriate volume of the filtrate for the indicated ammonia nitrogen range and transfer it to a 50 mL volumetric flask or graduated cylinder.

Standard Ammonia Solution, mL	Ammonia Nitrogen ug/50mL
50	01-1.0
25	11-2.0
10	2.1-5.0

If necessary, dilute to the 50 mL mark with NH_3 – fee distilled water.

Add 0.05 to 0.1 mL (1 to 2 drops) Rochelle salt solution and mix well.

Add mL Kessler's reagent with a safety pipette.

Stopper and mix well.

Allow the yellow or brownish color to develop for at least 10 minutes

Read the absorbance at 425 nm with a spectrophotometer.

Determine the microgram NH_3- N from the calibration curve:

Calculation:

mg/L NH_3- = μg NH_3-N

Ml of sample

mg/L NH_3- = μg NH_3-Nx1.22

Ml of sample

mg/L NH_4- = μgNH_3-Nx1.29

Ml of sample

NITRATE NITROGEN

Phenoldisulfonic Acid Method

Determine the chloride content of the water sample and treat 100 mL with an equivalent amount of silver sulfate solution (1mL for l mg C1) to precipitate the chlorides.

Remove the precipitated chloride either by centrifugation or by filtration, coagulating the AgC1 by heat if necessary.

If the sample has color of more than 10 unit (on platinum cobalt scale), decolorize by adding 3 mL aluminum hydroxide suspension to 150 mL sample; stir very thoroughly; allow to stand for a few minutes; then filter, discarding the first portion of the filtrate.

Pipette a suitable quantity of the sample or the clarified filtrate into an evaporating dish and neutralize to approximately pH 7

Evaporate to dryness over a hot water bath.

Add 2 mL phenoldisulfonic acid reagent and rub the residue thoroughly to insure dissolution of all solids. If needed heat on the water bath a short time to dissolve the entire reside.

Dilute with 20 mL of distilled water and add with stirring about 6 to 7 mL of NH_4OH or about 5 to 6 mL KOH solution (12N) until maximum yellow color is developed.

Remove any resulting flocculent hydroxides by filtration or add the EDTA reagent drop wise with stirring until the turbidity re dissolves

Transfer the filtrate of clear solution to a 50-mL volumetric flask or graduated cylinder. Rinse the dish, glass rod and filter paper with distilled water, adding the rinsing to the flask or cylinder until all the colored solution has been transferred.

Dilute to the 50- mL mark with distilled water, and mix thoroughly

Measure the absorbance at a wave length of 410 nm against a blank prepared from the same volumes of reagents as used for the samples.

Construct a calibration curve in the range 0-2 mg/L NO_3 – N by adding 0, 0.2, 0.5, 1.0, 3.0, 5.0, and 10 mL of standard nitrate solution to separate evaporating dishes and treating them in the same way as the sample.

Determine the μg of NO_3- N in the sample by reference to the calibration curve.

Calculation:

a) mg/L NO_3-N = μg NO_3-N

mL sample

b) mg/L NO_3 = µg NO_3- N X 4.427

mL sample

NoteNitrite levels in excess of 0.2 mg/L erratically increase the apparent Nitrate concentration as it responds like nitrate. Hence, the nitrite must be converted to nitrate by a suitable oxidizing agent prior to the determination of nitrate.

Nitrite Conversion

To 100 mL of sample add 1 of 1N sulphuric acid and stir, Add drop wise with stirring 0.1N $KMn0_4$ solution. Let the treated sample stand for 15 minutes to complete the conversion of nitrite to nitrate. (A faint pink color persists for at least 15 minutes when sufficient $KMnO_4$ is used.) Make the proper deduction at the end of the nitrate determination for the nitrite concentration as determined by the method described in nitrogen nitrite.

PHOSPHATE

Stannous Chloride Method

A) Determination of Orthophosphate

Prepare the following series of phosphate standards by measuring the indicated volume of standard phosphate solution into separate 100 mL volumetric flasks

(Or graduated cylinders).

Standard Phosphate Solution. Ml	Phosphate (PO_4^{3}) µg/100 mL
0	0
1	5
2	10
3	15
4	20

5 6	25 30

To the sample, add 0.05 ml 1 drop) of phenolphthalein indicator solution. If the sample turns pink, add strong acid solution drop wise until the color is discharged

With a measuring pipette, add 4 mL acid- molybdate solution to each of the standards and sample

Mix thoroughly by inverting each flask four to six times.

With medicine dropper, add 0.5 mL (10 drops) of stannous chloride solution to each of the standards and sample.

Stopper and mix by inverting each flask four to six times

After 10 minutes, but before 12 minutes, measure the color photo metrically at 690 nm using distilled water as blank.

Construct a calibration curve using the standards and determine the amount of phosphate in μg present in the sample.

Calculation

Calculation

a) mg/L PO_4^3 = μg phosphate

Ml of sample

b) mg/L P =μg PO_4^3-X 0.32614

Ml of sample

C) mg/L P_2O_5 =μg PO_4^3 x 1.4946

Ml of sample

B) Determination of Total Phosphate

Take a 50 mL sample in a 250 mL Erlenmeyer flask and dilute to 100 mL with distilled water

Add 1 drop (0.05 mL) of phenolphthalein indicator solution

If a pink color develops, add strong acid solution one drop at a time until the pink color disappears. Then add 1 mL extra of the acid solution.

Boil the acid- treated sample gently for 90 minutes, adding distilled water from time to time to keep the volume between 25 and 50 mL .

Cool to room temperature.

Stirring the sample constantly; add sodium hydroxide solution until a faint pink color reappears.

Transfer sample to a 100 mL volumetric flask or graduated cylinder

Rinse the flask, glass beads, and stirring rod with distilled water and add the wash to the flask/cylinder and dilute to the 100 mL mark with distilled water.

Complete the determination as described for orthophosphate starting with step 3.

Calculate the total phosphate using the formulae given for orthophosphate.

TOTAL SUSPENDED SOLIDS

Dried at 103-105-$^{0}{}_{c}$

Gravimetric Method

Preparation of glass-fiber disk

Insert disk with wrinkled side up in filtration apparatus

Apply vacuum and wash disk with three successive 20-mL portions of distilled water continue suction to remove all traces of water, and discard washing

Remove filter from filtration apparatus along with the Gooch crucible, and dry in an oven at 103 to $105^{0}{}_{c}$ for 1 hour. If volatile solids are to be measured, ignite at 550 $\pm 50^{0}C$ for 15 minutes in a muffle furnace.

Cool in desiccators to balance temperature and weighing until a constant weight is obtained or until weight loss is less than 0.5 mg between successive weightings.

SAMPLE ANALYSES

I) Assemble filtering apparatus and filter and begin suction. Wet filter

With a small volume of distilled water to seat it.

2). Filter a measured volume of well mixed sample through the glass fiber filter.

3). Wash with three successive 10-mL volumes of distilled water, allowing complete drainage between washings and continue suction for about 3 minutes after filtration is complete.

4) Remove the crucible and filter combination from the crucible adapter if a Gooch crucible is used.

5) Dry for at least I hour at 103 to $105^0{}_c$ in an oven,

Cool in a desiccators to balance temperature, and weigh.

Calculation

$$\text{mg suspended solids/L} = \frac{(A-B)x1000}{\text{ML sample}}$$

Where:

A= Weight of filter + dried residue, mg

B= Weight of filter, mg

b. solid samples- if the sample consists of discrete pieces of solid material (dewatered sludge, for example) pulverize the entire sample coarsely on a clean surface by hand using rubber gloves. Place 25 to 50g in prepared evaporating dish and weigh. Place in an oven at 103 to 105^0C overnight cool to balance temperature in a dedicator and weigh.

B) Fixed and volatile solids –Transfer to a cool muffle furnace, heat fumace to 550 ± 50^0C and ignite for 1 hour (if the residue from 2) above contains large amounts of organic matter, first ignite the residue over a gas burner and under and exhaust hood in the presence of adequate air to lessen losses due to reducing conditions, and to avoid odor in the laboratory) cool in desiccators to balance temperature and weigh.

3) Calculation

$$\text{mg volatile solids/L} = \frac{(A-B)\times 1000}{\text{mL sample}}$$

Where:

Weight of residue + dish before ignition, mg

Weight of residue + dish or filter after ignition, mg and

Weight of dish or filter, mg

Annex 3 macroinvertebratedistributions and their family, order, feeding group and tolerance along sites.

Order	Family	FFG	Tolerance value	Reference
Ephemeroptera	Baetidae	Collector/Gatherers	4(Moderate)	Bouchard et al, 2004
Hemiptera	Belostomatidae	Predators	10(HIGH)	Bouchard et al, 2004
	Corixidae	Filterer-collector	9(High)	Bouchard et al, 2004
	Naucoridae	Predators	5(moderate)	Bouchard et al, 2004
	Nepidae	Predators	8(High)	Bouchard et al, 2004
Odonata	Calopterygidae	Predators	5(Moderate)	Bouchard et al, 2004
	Codulegastidae	Predators	3(LOW)	Bouchard et al, 2004
	Coenagrionidae	Predators	9 (High)	Bouchard et al, 2004
	Corduliidae	Predators	7 (High)	Bouchard et al, 2004
	Libellulidae	Predators	7 (High)	Bouchard et al, 2004

	Macromiidae	Predators	7(High)	Bouchard et al, 2004
Diptera	Ceratopogonidae	Predator	6(moderate)	Bouchard et al, 2004
	Culicidae	Filterer-collector	8(High)	Bouchard et al, 2004
Coleoptera	Dytiscidae	Scrapers	5(moderate)	Bouchard et al, 2004
	Elmidae	Scrapers	5(moderate)	Bouchard et al, 2004
	Hydrophilidae	Scrapers	5(moderate)	Bouchard et al, 2004
Trombidiformes	Hydracarinidae	Predators	4 (moderate)	Bouchard et al, 2004
Gastropoda	Planoribidae	Scrapers	7(High)	Bouchard et al, 2004
	Pysidae	Collectors	7(High)	Bouchard et al, 2004
	Thiariidae	Scrapers	7(High)	Bouchard et al, 2004
Bivalvia	Sphaeriidae	Filterer-collector	7(High)	Bouchard et al, 2004

Annex 4. Supplementary Data of Macroinvertebrate assemblages collected at each sampling sites

Sites	K1	K2	K3	K4	K5	A1	A2	A3	A4	A5	B1	B2	B3	Ak1	Ak2	Ak3	Ak4	Ak5
Baetidae	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0
Belostomatidae	7	1	1	1	1	2	1	0	0	0	1	0	1	1	2	6	8	0
Calopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	5
Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cordulegastridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Coenagrionidae	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corduliidae	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corixidae	4	45	4	4	205	6	5	35	2	0	10	6	1	8	5	210	205	0
Culicidae	0	0	0	0	0	1	1	0	0	6	4	0	2	1	7	2	1	21

Dytiscidae	16	8	25	16	3	12	2	37	2	2	205	4	8	15	11	15	205	11
Elmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	45
Hydracarinidae	3	4	1	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0
Hydrophilidae	0	1	0	0	0	0	1	1	1	0	0	1	0	2	5	5	0	0
Libellulidae	0	1	2	1	0	0	0	0	2	0	2	0	0	0	0	0	1	2
Macromiidae	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Naucoridae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nepidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Planoribidae	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Pysidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Sphaeriidae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Thiardae	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0

Annex 5. Supplementary Data of birds at assemblages collected at each sampling site.

SISites	Africa Jacana	Cattle Egrete	Crab-plover	Egyptian Goose	Goliain Heron	Pink-backed Pelican	Senegal coucal	White backed duck	White faced whiting duck
K1	5	2	4	0	0	26	0	0	0
K2	10	1	0	1	0	10	0	0	0
K3	5	0	0	0	0	5	0	0	0
K4	0	0	0	0	1	15	0	0	0
K5	0	4	0	0	0	0	0	0	0
A1	0	11	0	0	0	0	0	4	0
A2	0	1	3	0	2	0	0	21	0
A3	5	0	0	0	0	2	0	0	0
A4	0	0	0	0	0	0	0	5	0
A5	0	0	0	0	1	0	0	0	0

B1	5	0	2	0	0	0	0	0	0
B2	0	10	1	5	1	0	0	0	0
B3	0	0	0	7	4	0	0	0	0
AK1	0	50	0	10	0	0	1	0	0
AK2	15	23	1	5	0	1	0	0	30
AK3	25	0	5	1	0	1	0	0	0
AK4	0	0	15	6	1	3	14	1	10
AK5	0	0	10	5	3	1	0	0	0