

THE IMPACT OF DRYSEASON AGRICULTURAL ACTIVITY ON PLANT BIODIVERSITY OF VALLEY BOTTOM ANFAFI WETLAND, SEYO DISTIRICT, KELEM WOLLEGA ZONE, OROMIA REGIONAL STATE, WESTERN ETHIOPIA

By

DEBELA TOLINA IRANA

Addis Ababa, Ethiopia

August, 2018



THE IMPACT OF DRYSEASON AGRICULTURAL ACTIVITY ON PLANT BIODIVERSITY OF VALLEY BOTTOM ANFAFI WETLAND, SEYO DISTIRICT, KELEM WOLLEGA ZONE, OROMIA REGIONAL STATE, WESTERN ETHIOPIA

By

DEBELA TOLINA IRANA

A THSIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDISABABA UNIVERSITYIN PARTIAL FULFILLMENT OF THE REQUERMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN GENERAL BIOLOGY

ADDIS ABABA UNIVERSITY DEPARTEMENT OF ZOOLOGICAL SCIENCE

Addis Ababa, Ethiopia

August, 2018

DECLARATION

This is to certify that the thesis prepared by Debela Tolina Irana, entitled: The impact of dry season agricultural activity on plant biodiversity of Anfafi wetland in Seyo District Kelem Wollega Zone Oromia Region. And submitted in fulfillment of the requirements for the degree of Master of Science in Biology complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

NAMES AND SIGNATURE OF THE EXAMINING BOARD:

Name	Signature	Date
1._____	(Examiner) _____	_____
2._____	(Examiner) _____	_____
3. BikilaWarkineh (PhD)	(Advisor)_____	_____
4._____	(Chair man) _____	_____

Acknowledgment

First of all I would like to say thank and special gratitude to my advisor Dr. Bikila Warkineh for his continuous advice and guide starting from the selection of the thesis title up to the final completions of this thesis work. I treasure his advises which have contributed a great deal to success of this work.

I wish to acknowledge the contribution of Seyo woreda Agricultural and natural resource office and rural land administrative and land use planning office for providing me all the value able materials and information. I would like to appreciate individuals who have contribution to the completion of this work.

Special thanks also go to all members of all the sample communities who freely gave of time, information, and patience during the individual interview/questionnaire.

Finally thanks go to all my families and friends, Tigist Eliyas, Bontu Tolina, Magarsa Shuma, Tizazu Tesfa and Olani Tamene for their friendly support during this work. Last but not least, I remain sincere, grateful to my Father Tolina Irana and my mother Jitu Chawaka and all my brothers, whose words of encouragement and prayer served me as a source of strength and inspiration throughout my study.

Contents

DECLARATION iii

Acknowledgment iv

Table of contents iii

List of Tables iv

List of Figures v

Abstract vi

Acronyms vii

1. Introduction 1

1.1 Back ground 1

1.2 Statement of the problem 2

1.3 Objective of the study and Research Questions 3

2. Literature review 4

2.1 Type of wetlands 4

2.2 Importance of wetlands 5

2.3 Impact of agriculture and other human activities on wetlands 7

2.4 Wetland management and sustainable utilization 11

3.1.1 Location 14

3.1.2 Demographic structure 14

3.1.3 Topography, altitude and climate 16

3.2 Materials 16

3.3 Methods 16

3.3.1Preliminary survey 16

3.3.2 Method of data collection 16

3.4 Data analysis 18
3.4.1 Species diversity analysis 18
3.4.2 Species richness analysis 19
3.4.3 Species similarity index 19
4. Results 20
4.1 Plant species Composition and Diversity in valley bottom Anfafi Wetland 20
4.1.1 Plant species composition in degraded and natural Anfafi wetland 20
4.2 Plant species in natural valley bottom Anfafi wetland 21
4.3 Plant species in degraded valley bottom Anfafi wetland 22
4.3.1 Plant species in grazing area 22
4.3.2 Plant species in coffee area of Anfafi wetland 24
4.3.3 Plant species in irrigation area of Anfafi wetland 26
4.4 Plant species diversity in natural and degraded valley bottom Anfafi wetland 26
4.4.1 Species diversity index 26
4.5 Species similarity index 28
4.5.1 Simpson's similarity index between natural and degraded Anfafi wet land 28
4.6 Comparison of plant species composition and diversity in natural and degraded site of Anfafi wetland 29
4.7 Sample house hold character 29
4.7.1 House hold size, age, and education 29
4.8 Wetland resource utilization 31
4.8.1 Agriculture land 31
5. Discussion 34
5. 1 Plant species in valley bottom Anfafi wetland 34
5.2 Valley bottom Anfafi wetland degradation 34
5.3 The main cause of valley bottom Anfafi wetland threats 35
5.3.1 Population pressure 35
5.3.2 Irrigation 35

5.3.3 Coffee production 35
5.3.4 Livestock production 36
6. Conclusion and Recommendation 37
6.1 Conclusion 37
6.2 Recommendation 37
Reference 39
Annex1. 44
Annex 2 48
Appendix 1: Plates 49
Appendix 2: 52

List of Tables

TABLE 1 DISTRIBUTION OF RESPONDENTS BY THEIR KEBELES 17
TABLE 2 RECORDED PLANT SPECIES IN NATURAL ANFAFI WETLAND 20
TABLE 3 PLANT SPECIES IN GRAZING WETLAND AREA 23
TABLE 4 PLANT SPECIES IN COFFEE AREA IN ANFAFI WETLAND 25
TABLE 5 SPECIES DIVERSITY INDEX OF NATURAL VALLEY BOTTOM ANFAFI WETLAND 27
TABLE 6 SPECIES DIVERSITY INDEX OF IRRIGATION SITE OF WETLAND 27
TABLE 7 SPECIES DIVERSITY INDEX OF GRAZING SITE OF WETLAND 27
TABLE 8 SPECIES DIVERSITY INDEX OF COFFEE FOREST SITE OF WETLAND 28
TABLE 9 COMPARISONS OF PLANT SPECIES DIVERSITY 29
TABLE 10 HOUSE HOLD SIZE OF SAMPLE POPULATION 30
TABLE 11 RESPONDENT'S AGE DISTRIBUTION 30
TABLE 12 EDUCATIONAL STATUS OF SAMPLE HOUSEHOLD 30
TABLE 13 AREA OF LAND UNDER DIFFERENT USE SYSTEM (HECTARE PER HOUSEHOLD) 32

List of Figures

FIGURE 1 MAP OF THE STUDY AREA (PHOTO: DEBELA, 2018) 15
FIGURE 2 THE PERCENT OF PLANT SPECIES IN NATURAL WETLAND AREA. 22
FIGURE 3 ..... **ERROR! BOOKMARK NOT DEFINED.**
FIGURE 4 PERCENT OF PLANT SPECIES IN COFFEE FOREST AREA OF ANFAFI WETLAND 25
FIGURE 5 PERCENT OF PLANT SPECIES IN ANFAFI WETLAND (SOURCE: AUTHOR FIELD SURVEY, JANUARY, 2018) 26
FIGURE 6 SOURCE OF FEED FOR LIVESTOCK. 32
FIGURE 7 AREA OF LAND UNDER DIFFERENT USE SYSTEM (HECTARE PER HOUSEHOLD) DECREASED BETWEEN 2008 AND 2018. 33

Title: The impact of dry season agricultural activity on plant biodiversity of valley bottom Anfafi Wetland in Seyo District Kelem Wollega Zone Oromia Regional State Western Ethiopia

By Debela Tolina Irana

Date: August, 2018

Abstract

Valley bottom Anfafi wetland is undergoing degradation through human activities from the adjacentcommunities. This study was conducted to assess the impact of dry season agricultural activities on plant biodiversity of Anfafi wetland. The specific objectives were to identify the effect of irrigation and other human activities on plant biodiversity of wetland and sustainability with regard to wetland conservation, assess and compare plant species composition and diversity between degrade and natural wetland zones. Anfafi wetland was classified into natural wetland zone, irrigation areas, grazing land and coffee production area. Different methods were used to collect primary and secondary data. Fortyquadratic sample plots (10 plots in each zone) were established along transects. Secondary data were collected from 66 farmer households; using questionnaire and interview with different social groups. The sample respondents were drawn from two kebeles peasant association adjacent to the wetland. The result indicates that more than 99 percent of sample households depend on the wetland for different types of activities including crop production, livestock production and construction materials. In recent years, this wetland was degraded progressively due to anthropogenic impact. Natural wetland ecosystem and preexisting wetland plants were not conserved. The main cause of this wetland threats was irrigation activity, overgrazing and the expansion of coffee productions around wetland. The difference between natural and degraded wetland zone was assessed by using Simpson's diversity index and Shannon-Wiener diversity index. Vegetation analysis revealed that plants dominating degraded wetland area were different from those of natural wetland zones in both composition and diversity. Simpson's diversity index in the natural wetland was 0.38 implying high plant species diversity. Simpson's diversity index of degraded wetland zone (irrigation area, grazing land, and coffee production site) was 0.62, 0.59 and 0.92 respectively. This implies less plant species diversity in degraded wetland zones. It was indicated high disturbance which affected the areas very adversely. Species richness of natural wetland, grazing land, irrigation area and coffee forest area were 3.24, 0.94, 0.85 and 1 respectively. Species evenness index were also 0.62, 0.41, 0.38, and 0.08 respectively. Simpson's similarity indices of 17% observed between natural wetland and degraded wetland zones in Anfafi wetland show that there were differences between degraded and no degraded wetland zone. Sustainable utilization and managing the wetland on the basis of basin concepts and involving local people in alternative income generating activity has been suggested as a means of reducing pressure on wetland use and also reducing the threat to wetland.

Key words: Wetland, plant biodiversity, dry season, sustainable utilization, agriculture.

Acronyms

ADAs	Agricultural Development Agency
CSA	Central Statistics Agency
D	Simpson's diversity index
DI	Diversity Indices
EPA	Ethiopia Environmental Protection Authority
EWNRA	Ethiopian Wetlands and Natural Resources Association
FAO	Food and Agricultural Organization of the United Nation
GPS	Geographic Positioning System
H'	Shannon Wiener Diversity Index
HH	Household
IWMI	International Wetland Management Institutions
MNRT	Ministry of Natural Resource and Tourism of Tanzania
NCSU	North Carolina State University
RI	Species richness
SDARDO	Seyo District Agricultural and Rural Development Office
SI	Simpson's Similarity Index
USEPA	United State Environmental Protection Agency
WCED	World Commission for Environment and Development

1. Introduction

1.1 Back ground

Wetlands are ecosystems or unit of the landscape that are found on the interface between land and water. The Ramsar convention (1971) defines wet lands as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands vary according to their origin, geographical location, water regime, chemistry and soil (Hook et al., 1988). Wetlands can be classified in various ways. Keddy (2000) classified wetlands in to six basic types i.e. swamp, marsh, bog, fern, wet meadow and shallow water. Wetlands occupy about six percent (6 %) of the world‘s land surface (Hook et al., 1988) and about two percent (2%) of Ethiopia land surface (EWNRA, 2008). According to EPA (2004), wetlands accounts for 2% of the total land mass of Ethiopia. Ethiopia has diverse wetlands of various origins that distributed in many parts of the country. A large number of Ethiopians depend on wetland resources for their survival (Wood et al., 2002). Major rivers and lake systems, together with their associated wetlands are fundamental parts of life interwoven into the structure and welfare of societies and natural ecosystem. Ethiopia wetlands are of considerable ecological and social economic values. Ecologically, wetlands are instrumental in water storage filtration and supply, flood control, control sediments, nutrient and toxin retention functions and are also important for biodiversity conservation both flora and fauna. Socially and economically, wetlands support family livelihoods as bases for crop production, grazing animals, fishing and harvesting medicinal plants among others. Wetlands have been used for agriculture for thousands of years. They provide a range of valuable ecosystem services, such as the provision of food and clean water, the retention of soil and the cycling of nutrients. Wetlands are very important for the rural livelihood (IWMI, 2002).They supply families with basic needs such as water and construction material. The abundance of water in the wetlands also supports the growth of dense sedge vegetation known locally as “Caffee” (*Cyprus lactifolius*) which in addition to providing limited agricultural usage fodder for cattle is traditionally harvested by local communities for use as a roofing and craft material. It is also used throughout the year aarrange of ceremonies and celebration and as such it is a marketable commodity. However, wetlands are at risk mostly due to population pressure in Ethiopia. The value of these services was sometimes underestimated. In some areas, the drainage reclamation of wetlands for

agriculture has been widespread, but there was increased recognition of the critical interdependencies between agriculture and healthy wetlands. Wetlands have progressively been lost and degraded due to human activities for many years. The most common threats of wetlands are the result of a combination of social, economic, and climatic factors, which have increased pressure on the natural resources in Ethiopia. Wetland loss, destruction and alteration have been and are still seen as an advanced mode of development, even at the government level (Abebe and Geheb, 2003). A large number of wetlands in Ethiopia are considered vulnerable zones and some of the most exploited, mismanaged and lost their regenerating capacity (Alemayehu, 2006). Ethiopian wetlands are increasingly being lost or altered by unregulated over utilization, including water diversion for agricultural intensification, urbanization, population pressures, food shortages, increasing drainage and cultivation, collection of sedges and reeds for roofing and housing, pollution and other anthropogenic interventions (Mulugeta, 2004).

1.2 Statement of the problem

Western part of Ethiopia is interspersed with innumerable valley bottom wetlands, which are of major importance in agricultural and pastoral systems. However, wetlands are being degraded at an alarming rate in western part of Ethiopia. Draining and converting of wetlands in to farmland are common in several parts of Ethiopia especially in areas where there is a shortage of cultivable land and rapid population growth. The major human factors leading to the degradation of wetland in Ethiopia are included conversion to agricultural land, expansion of human settlement, overgrazing, and over exploitation of wetland resources. Drainage of wetland or unsustainable extraction of ground water in the area will dry it out and may cause permanent damage and impair wetland's ability to control flooding, since the soil has reduced capacity to reabsorb water (Birhanu, 2003). In the same way the wetland of the study area is exposed to several degrading factors due to high population growth and scarcity of farm land and lack of proper management. In Seyo district, there is no any research carried out to investigate the impact of human activity on plant biodiversity of wetland.

1.3 Objective of the study and Research Questions

General objective

The general objective of this study is to investigate the impact of dry season agricultural activity on plant biodiversity of wetland in Seyo district.

Specific objectives

- To identify the major threats of wetland resources and analyzing its effect on wetland ecosystem.
- To assess plant species diversity in degraded and natural wetland area.
- To compare plant biodiversity of the degraded wetland with natural wetland
- To identify the effect of agriculture on natural wetland ecosystem
- To assess the socio- economic importance of the wetlands under the study and give some recommendations for future management and conservation of the wetland

Research Questions

1. What are the main causes of wetland degradation?

2. What is the socio-economic importance of Anfafi wetland?

3. What are the possible solutions for the sustainable use/ management of this wetland?

2. Literature review

2.1 Type of wetlands

Classification of wetland types can be a very in depth and complicated process, because the more one considers the variations in wetland characteristics, the more categorizations can be created. However such in depth processes would be outside the scope of this study. One of the most basic classification schemes shall be considered compare to a more advanced system, which will illustrate the point of how complex these classifications can truly be. There are four main types of wetlands in a basic system of classification: swamp, marsh, bog, and fen (Keddy, 2000). The following descriptions are based upon a synopsis of literature by Keddy (2000) and More (2008). **Swamp (Carr)** "A wetland community by trees with a developed leaf canopy, which has invaded from nearby areas in to herbaceous marshes and fens, rooted in hydric soils, but not peat."

Marsh- "A wetland community dominated by herbaceous plants, usually emergent through water and rooted in hydric soils, but not peat.

Bog- "A wetland community dominated by sphagnum moss, sedges, ericaceous shrubs or ever green trees rooted in deep, sometimes un compacted peat."

Fen- "A wetland community usually dominated by sedges and grasses rooted in shallow peat, often with considerable water movement through the peat." More advanced classification system such as those used by the Ramsar Convention (1971) should be considered for comparison.In this system, there are five main wetland systems. The five systems, based up on observations from Ramsar Convention (1971) are:

Marine- Costal wetlands including coastal lagoons, rocky shores, and coral reefs;

Estuarine- including deltas, tidal marshes, and mangrove swamps;

Lacustrine- wetland associated with lakes;

Riverine- wetland along river and streams; and

Palustrine- meaning "marsh"-marshes, swamps, and bogs.

The complexity of wetland ecosystems has led to various definitions by different authors (Mitsch and Gosse link, 1993) but an internationally accepted definition, which encompasses most of the wetland characteristics found in different regions is given in Article 1.1 and 2.1 of the Ramsar Convention as "area of marsh, fern, peat land, or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh or brackish or salt, including areas of marine water the depth of which does not exceed six meters" (Ramsar Convention Bureau, 1997). Wetlands, as defined in the Ramsar Convention, include all lakes and open water as well as different types of permanently or seasonally wet ground. If one takes in to account all areas covered by this definition, the wetlands of Ethiopia cover a total of 18,587km^2.This was approximately 1.5% of the total area of the country, (Ethiopian Environmental Protection Authority, 2003).According to Ethiopia Environmental Protection Authority (2003), there were four major types of wetlands in Ethiopia. These are seasonally inundated wetlands, fresh water wetlands, saline wetlands and marsh wetlands. Among these wetlands, seasonally inundated wetlands were covered 8720km^2 (47%) and fresh water wetlands were covered 5767km^2 (31%). Marsh wetlands were covered 2330km^2 (12.50%) while saline wetlands were 1770km^2 (9.50%). These large areas of seasonally inundated and fresh water wetlands in Ethiopia were very useful for agricultural activities; contributed drinking water and other livelihoods.

2.2 Importance of wetlands

Wetlands are important resources in Ethiopia that sustains rural livelihoods, particularly in areas with low or unpredictable rain fall, land scarcity or where uplands have poor soil characteristics and thus low potentials for agriculture (Dixon and Wood, 2003). For centuries, Ethiopia's wetlands have supported life of human populations that have developed specialized strategies to utilize the agricultural, fishing, hunting, and grazing potentials and other resources that the wetlands can provide. Wetlands provide natural resources and services for humanity. They are source of food, tourism, cultural resources, flood control and improve water quality. They are also important to biodiversity and wildlife conservation (Desta, 2003). As noted earlier by Hailu (2003), wetlands play a crucial role in the well being of citizens in lesser developed nations. According to Hailu (2003), wetlands are used virtually by all households in Western Wollega and Illubabor zones in Ethiopia directly or indirectly. The main uses are social/ ceremonial reeds, medicinal plant, thatching reeds used for housing construction granary roofing, domestic water

supplies, dry season grazing land, water for livestock, and temporary crop-guarding huts of reeds, cultivation and craft materials. Dixon (2008), noted that "caffee" (*Cyprus latifolius*) is the dense reed vegetation used for roofing, craft material, fodder for cattle, and as a marketable commodity in a range of ceremonies and celebrations in Ethiopia. Furthermore, minor uses such as establishing coffee and tree nurseries on wetland fringes, clay collection for pottery, and uses of wetland tree bark for making ropes were also noted. The indirect uses of wetlands are due to their hydrological and ecological functions, which support various economic activities, life support system and human welfare. This includes ground water recharge, flood control, nutrient recycling, erosion control, and sediment traps, climate regulation, stream flow moderation, water filtration and purification, plant and fish products, biodiversity, wildlife habitat for migratory wildlife and pest control (Dugan, 1990). According to Abebe and Geheb (2003), wetlands also support crop production and fishing, source of medical plants among others. Ecologically, wetlands are instrumental in water storage, filtration and supply, flood control; perform sediment, toxins retention functions, and habitats for biodiversity of both flora and fauna (Abebe and Geheb, 2003).Among their many valuable functions, wetlands filter pollutants that might otherwise flow into rivers, streams or lakes. Wetlands are often referred to as "kidney of the landscape." Riparian wetlands, whose sponge like quality enables them to store heavy rains that could otherwise cause floods, also help to prevent erosion of streambeds (MNRT, 2003). Wetlands are the breeding, feeding and nesting grounds for many endangered species including plants, non-endangered wildlife natural communities. Wetlands are also used for recreational activities such as bird watching, canoeing, fishing and hiking. The economic, environmental and recreational values of wetlands are immeasurable. The only continent with no wetlands is the Antarctica (Wambura, 2004). Wetlands are endowed with a host of functions that provide beneficial goods and services to mankind (Ellis, 2000).

Importance of wetlands in hydrobiology: Wetlands are natural filters that improve the quality of the water that flow through them (Kadlec et al., 1979). Good water quality allows a rich assemblage of plant and animal life to develop. The presence of a dense growth of vegetation and high plant biodiversity, together with considerable contact between water and sediments through sheet-flow promotes anaerobic and aerobic processes that can remove pollutants and enable organic matter to accumulate in the soil (Mitsch et al., 1993). Sediment accumulations of 6 to 20 mm per year have been reported in United Sates of America and deposits of up to 50% of

the suspended load have been reported in New-Zealand (Mitsch et al., 1993). Nitrogen and phosphorus loading to wetlands comes from runoff leaching from fertilized crop lands (Hemond et al., 1988) but excess nutrients can be filtered out as water flows through the wetland. Nitrogen is removed by vascular plants and microorganisms de nitrification and ammonia volatilization (Delaune et al., 1986) although de nitrification by anaerobic bacteria is the primary mechanism by which nitrogen is removed from wetland waters (Mitsch et al., 2000). Phosphorus is removed from wetlands mainly through adsorption on to mineral sediments (Richardson, 1985), but it is also removed through uptake by plants and by precipitation as insoluble phosphate of iron, aluminum, and calcium (Nichols, 1983). Organic pollutants such as pesticides and herbicides may reach wetlands through agricultural activity but are removed through sorption on to sediments (Hemond et al., 1988). Since wateris generally shallow in wetlands, they provide an ideal opportunity for photo degradation of pesticides (Zafiriou et al., 1984).

2.3 Impact of agriculture and other human activities on wetlands

According to Finlayson and Moser (1991), wetlands occupy about 6% of the land surface of the world, or approximately 890 million hectares but an estimate of 50% of worlds wetlands may have been already altered or lost in the last 50 years (Dugan, 1993).The degradation and loss of wetlands are more rapid than that of other ecosystem. Similarly, the status of both fresh water and coastal wetland species is deteriorating faster than those of other ecosystems (Francois et al., 2005). Now a days, widely recognized that many of the world's wetlands have been placed under considerable stress through anthropogenic disturbance to catchment surfaces and hydrology, and the direct release of human waste products (Gell et al., 2013). Areas with intensive agriculture around the world have often been created in river catchments by draining large wetland complexes and converting them to agricultural production (Hefting et al., 2013).Wetlands are often considered as waste lands, which should be transformed to useful systems, e.g., by traditional agricultural, forestry, husbandry and aquaculture, or for the construction of houses and infrastructure (Junk et al., 2013). Lack of adequate knowledge and awareness of social, economic and eco-system benefits of wetlands and the increasing demand for agricultural land due to population pressure and degradation of upland areas are believed to be the most significant reason for increased conversion of wetlands to agricultural lands. In Ethiopia, wetland resources play a vital role in the lives of adjacent communities by helping them to achieve food

security and livelihoods. However, many wetlands throughout the country are facing degradation as high population growth rate increases the need for more fertile agricultural land. Lack of awareness and logistic constraints are important reasons for the weak consideration of wetland ecosystems by the country's development planners (Mereta et al., 2012). Although wetlands have many known characteristics that are important to the livelihoods of local inhabitants, population pressure has caused massive encroachment. Agricultural developments in wetlands through either the use of drainage systems or change of land use to hydrophilic plants are among the causes for wetland loss. Wetlands in Ethiopia are currently being lost or altered by over utilization and unregulated management. Among such activities that are seriously affecting the wetlands are water diversion for agricultural intensification, urbanization, dam construction, pollution and other forms of intervention (Abunie, 1990). Draining of wetlands for agricultural purpose is a century old practices in some part of Ethiopia. However, improper draining mechanisms, double cropping, growing of perennial crops such as sugar cane within wetlands ecosystem have become major threats for survival of wetlands (Birhan et al., 2015). Traditional and modern agricultural expansions, continuous land degradations, urbanization, lack of policies and institutional arrangements, lack of capacities, natural and ecological problems are the most dominant challenging factors of wetlands in Ethiopia (Gebresllassie et al., 2014). Sugarcane, banana and 'chatt' cultivation on the periphery of the wetlands and 'teff' cropping in the wetlands has been identified as a threat for the survival of wetlands in Ethiopia. Moreover grazing by domestic stocks has also been identified as threats of wetlands (Gebresllassie et al., 2014). The unsustainable use of wetlands for cultivation was creating the degradation and/or loss of wetland system and their precious resources. The major problem associated with unsustainable utilization of wetland for cultivation is lack of proper ownership structure and legal supports over illegal holding of wetlands and its utilization (Mulatu et al., 2015). Though natural factors, ecological factors and lack of potential are important wetland influencing factors, the most sever and coming severing threats are those related anthropogenic factors. Most of these anthropogenic factors are raised due to engaging the stake holders on the immediate benefits and values of wetlands instead of the long term and sustainable benefits and values **(**Gebresllassie et al., 2014). Human activities have and continue to cause wetland degradation and loss in three main ways. Firstly, hydrological alterations, as any changes in hydrology can alter the soil chemistry and animal and plant communities. Secondly, pollution in puts, although wetlands are

adept at absorbing pollutants from surface water, there is a limit in their capacity to do so. Thirdly, native wetland plants become particularly vulnerable when subjected to grazing animals and invasive plants (United States Environmental Protection Agency, 2001). A major factor limiting the availability of resources from wetlands in Ethiopia comes from extensive farming which has increased largely over the past century in the Western Wollega (Dixon et al., 2008). Kumsa (2015) noted that the most serious threats to wetland in Western Wollega are unsustainable use of wetland resources through agriculture, overgrazing, over cultivation and over abstraction of water for domestic use. Wetland cultivation in this zone may date as far back as the mid-19th century, and possibly centuries earlier (Maconachie, 2008). Mulugeta maintains that cultivation of wetlands has existed here for at least eight decades, with an average cultivation of 23% of the total wetland area (Mulugeta, 2004). During this time period, cultivation extended beyond the use of wetland margins to include much larger wetland areas-complete drainage and cultivation is now common place throughout the region (Dixon and Wood, 2008). Coffee production in the early 19th century also placed pressure on starting further wetland cultivation, as more upland were being used for its cultivation, making it necessary to expand into new portions of habitats (Solomon, 1999, from Hailu, 2003). This expansion was largely due to a food shortage because of drought conditions (Hailu, 2003, Dixon and Wood, 2008). According to Hailu (2003), roughly 20% of the western Wollega and Illubabor zone wetlands were cultivated between1986-1998 and increasing drastically in 1999 to 35 percent. Some of this might be accounted for by increased government pressure from 1974-1991 as food–sufficiency targets were set for the region, and those unwilling to cultivate their wetland plots risked losing them to those who were willing to do so (Dixon and Wood, 2008). In addition, over 100,000 people were moved to the region by a government decision during a famine in 1984 (Dixon and Wood, 2008). In 1999, the government increased their pressuring of farmers to cultivate wetlands in order to compensate for more drought induced food shortages (Dixon and Wood, 2008). Mulugeta (2004) states that 70% of the farmers in the area have participated in these activities at least once, presumably due to this large amount of pressure put on farmers. And also his further notes that more than two-thirds of the people in this region depend on agriculture as their principle source of income Mulugeta, (2004). Wetland cultivation was provided between 10%-20% of the annual food needs of the region, but could be as high as 100% during the summer–months in some areas (Dixon and Wood 2008). Wetland

agriculture is characterized by networks of drainage ditches which lower the water tables, promote rapid drainage during and after precipitation and create conditions of continuous surface flow (Bruland et al., 2003). It has been reported that most of the wetland areas are experiencing immense pressure from human activities, the most important being drainage for agriculture (Bernard et al., 2002). Rijsberman and Sanjini (2004) reported that agriculture and wetlands have not had a very harmonious relationship. It has been observed that wetlands are lost or reduced in size through human process namely agricultural activities, over harvesting of wetland products, overgrazing and unsustainable fishing practices, use of agrochemicals and pollution by domestic sewage and industrial effluents, developmental activities, introduction of exotic species, poaching of wildlife and river diversion in unconfined irrigation (Kamuakala and Crafter, 1993). Agriculture has been observed to be a major threat to wetlands since in many cases it involves conversion of wetlands into farmlands (Rijisberman and Sanjini, 2004). The conversion of wetland to agricultural land has implications on all of their components; especially the soils that are the physical foundation of their ecosystems (Stolt et al., 2000). Wetland soils are characterized by low nutrient availability and low rates of soil process as a result of anoxic conditions in the soils (Mclatchey and Reddy, 1988, Aerts et al., 1999). Upon conversion to agricultural land, soils that were once subjected to reducing conditions and low rates of decomposition become subjected to oxidizing condition and high rate of decomposition (Armentano and Menges, 1986). Bernard et al. (2002) reported that agriculture practiced in high land catchments results in siltation to the wetlands of lowlands. He also reported of the changes in water quality due to agricultural pesticides. More over Bernard et al. (2002) reported of the introduction of alien species of flora and fauna due to agricultural activities. Consequently besides threatening of the provision of clean water and introduction of alien species, degradation of the wetlands also negatively influences agriculture (MNRT, 2004). Therefore wetlands need to be conserved in order to enjoy their goods and services such as water purification, water supply during the dry season, natural resource supply, and flood mitigation during heavy storms as well as coastal erosion control during high tides storm (Bush, 2ooo). This can only be achieved through wise utilization of wetland resources.

2.4 Wetland management and sustainable utilization

Ramsar convention (1971) defines natural properties of the wetlands ecosystem as those of physical, biological and or chemical components such as soil, water, plants, animals, nutrients and the interactions between them. Plant and animals living in wetlands exhibit evolutionary adaptation to such habitat condition such as high water availability, thus alteration of any physical function such as hydro period or water quality has repercussions on other functions and this chain of reaction affect the values attributed to wetlands since most wetlands have some standing water covering the soil surface for at least part of the year (Bush, 2000). Wetlands play a fundamental ecological role and have potential and are resources of great economic, cultural and scientific value (MNRT, 2006). Bush (2000) summarizes the common functions and uses of wetland ecosystems to be nutrient storage, accumulation of organic material for fuel or agriculture, filtering solid from waters, animal's habitats, plant habitats and regulating water out flow. Wetlands now play an increasingly important role in food security, sometimes as the last resort for domestic production by poor people, but in other cases they have been appropriated by rural elites for market oriented production (Wood, 2001). Dana et al. (1998) argued that, disregard for sustainability may reduce long term economic productivity and encourage environmental and ecological losses. In most developing countries, the productive nature of wetland ecosystem has not been valued forcing them in to a threatened category (Munishi and Kilungu, 2004). MNRT (2006) reported that high demand for wetland products and services had pushed towards unplanned and subsequent over harvesting or utilization of wetland resources and services leading into degradation of most wetland ecosystems. Bernard et al. (2002) also observed that the mechanistic view applied to wetlands has led to their destruction by the in ability or unwillingness to see and try to understand their importance for the function of the whole system. However, Munishi and kilungu (2004) argued that, when wetlands are wisely managed they can continue to provide support to poverty reduction and human wellbeing sustainably. Sustainable wetlands management can be viewed as a process of intervention between two extremes. One extreme is complete protection of wetlands in their pristine condition and the other is complete conversion for agriculture and other uses. Sustainable management involves balance between the biological concerns favoring protection and the socio-economic and equity needs of people which seek conversion of these areas. Hence, there is a need to accommodate some level of wetland conversion while at the same time maintaining or even

expanding their environment and hydrological services. Sustainable wetland management requires the active participation of the relevant stakeholders in the planning and implementing process (Siraj, 2004). The aim is to achieve the long term production of benefits from wetlands and the maintenance of the ecological functioning of these areas through designing and realizing appropriate policy measures. The Ramsar convention (1971) defines wise use as sustainable utilization of wetlands for the benefit of human kind in away compatible with the maintenance of natural properties of the ecosystems. The convention further defines sustainable utilization of wetlands as human use of wetland so that they may yield the greatest continuous benefit to present generations while maintaining their potential to meet the needs and aspirations of future generations. This is only possible through sustainable management of wetlands. Sustainable wetland management should ensure peoples continued access to the resources in ways, which maintain both their livelihoods and the resources on which they depend. In other words, the use of the resources for agriculture must be limited so that other benefits are not destroyed or seriously reduced (Wood, 2003). Sustainable management generally involves activities that can be conducted within, and around wetlands, both natural and manmade, to protect, restore, manipulate or provide for their functions and values (NCSU, 2006). The interest in sustainable use and adaptive management of tropical wetlands has increased in recent years (Finlayson, (2002). However, in Ethiopia the sustainability of these wetlands when subjected to different economic uses is not considered as in most cases people use their own knowledge in utilizing these resources. Sustainable of the production process requires that input from natural resources be given equal consideration to output or consumption because resources provide more services to society than simply producing goods (Dana et al., 1998). Conversely, it is difficult to assess environmental sustainability because it involves disparate social objectives and an understanding of complex ecological systems (Dana et al., 1998)

This investigation will test the hypothesis that the impact of human activities leads to decrease in the diversity of plants in valley bottom Anfafi wetland. It will provide information on changes in plant biodiversity and how it can influence the functioning of wetland ecosystem.

The main aim of this study is to compare pant communities in a relatively undisturbed wetland zone with those in one heavily affected by communal agriculture. This was done by determining the plant cover species diversity, species richness and evenness. This study will focus livelihood

of community around wetland and identifying the main cause of valley bottom Anfafi wetland degradation. And also to asses ecological and economic value of wetland and make awareness of community to sustainable utilization of wetland and other natural resources such as forest, water, upland and wild animals.

3. Materials and methods

3.1 Description of the study area

3.1.1 Location

The study was conducted in Seyo district which is one of the twelve districts of the Kelem Wollega Zone, Oromia regional state, Western Ethiopia. It is located at the distance of 637 Km from the capital city, Addis Ababa in western part of Ethiopia. The study site has Latitude $8^0$32'N and longitude $34^0$48'E with an elevation of between 1701 and 1827 meters. Seyo is bordered on the south by the Gambela region, on west by Anfillo woreda, on north by Yemalogi Welal, on North West by Hawa Galan, on east by the Birbir River which separates it from the Illubabor zone. The district comprises twenty six rural kebeles. Dembi Dolo town is the center of Seyo district administration. It is located at the distance of 652 Km from Addis Ababa. DembiDolo is the capital town of Kellem Wollega Zone and is located at $8^0$10'' N latitude and $34^0$20''E. The study was focused in between two kebeles of Seyo District namely Abichu Shogo and Mata. Anfafi wet land is found between these two kebeles. The study area was purposively selected for the study to represent agro-ecology of Seyo district. The community in the district practices mixed crop and livestock farming system as the mode of agricultural activity in which cattle and sheep as the major livestock, which are highly important for the livelihood of the local population. Crop cultivation is one of the main economic activities of the people living in this area where by major grown crops are maize, sorghum, beans, peas, wheat and coffee.

3.1.2 Demographic structure

Based on the 2007 National census reported by the CSA, the total population of the district was 116,631. Out of this 58,268 were Men and 58,363 were women. The total numbers of households was 22268 households were lived in Seyo District. The majority of the populations were Protestants, with 56.1% reporting that as their religion, while 25.72% observed Ethiopian Orthodox Christianity, 10.83% observed Islam, 5.84% were Catholic and 1.51% was others such as Wakefata.

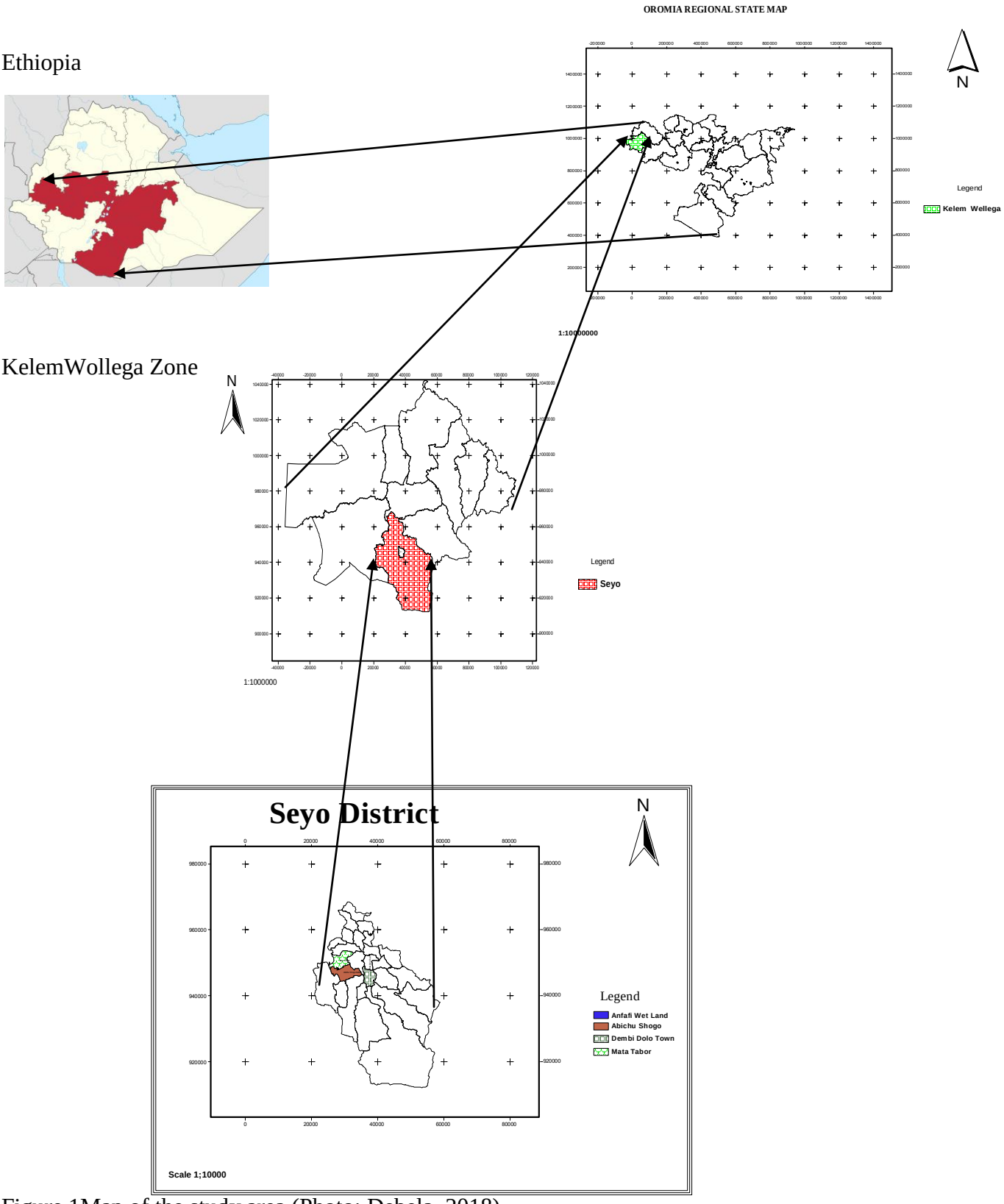


Figure 1Map of the study area (Photo: Debela, 2018)

3.1.3 Topography, altitude and climate

The Seyo district has varied topographic and climatic characteristics, which influence the vegetation cover, the soil and the weather characteristics. Its altitude ranges between 900- 2300 m. above sea level, it gently slops to the east, and its western part consists of high plateau, mountain peaks and rugged terrain. The climate is a medium and humid type. The monthly maximum rainfall of the area reaches 600-1500 mm. It is during the wet season that 80 - 90 percent of the total precipitation occurs. The average annual temperature of the area is 19^0C. The mean monthly temperature varies significantly throughout the year; i.e. from 10^0C to 28^0C (Seyo District Agricultural and Rural Development Office, 2016).

3.2 Materials

Materials were used during the study period include Digital camera, geographic positioning system (GPS), Excel, a stake and rope (quadrates) and hand note.

3.3 Methods

3.3.1Preliminary survey

Preliminary survey was conducted in the study area from the first week of November 2017 to December 2017 to collect information about the study area (plant species, livelihood, climatic condition, topography, and approximate size of area).

3.3.2 Method of data collection

3.3.2 .1 Sampling procedure and sample size

Anfafi wetland is found between Abichu Shogo kebele and Mata kebele. Majority of this wetland is found in Abichu shogo kebele. From these two kebeles, I selected Sako, Agalo sako, Hamdo chaka and koli villages for this study purposively. These villages are selected on the basis of their direct interaction (adjacent to) with wetland and areas of high community interaction/ impact on the wetland resource. The primary data were collected by observation while secondary data were collected by employing questionnaire and interview with different social groups.

Primary data: Primary data was gathered by using quadratic method. Sample plot was represented 70% of the total wetland area. The sample was taken by means of the (2m) (2m)

quadrate technique, and recorded species richness, species abundance, species similarity between degraded and natural wetland area and also percentage cover in each habitat.

The actual field work was carried out from January 2018 to April 2018. At least two season cycles (wet and dry seasons) was recommended having a good survey of plant biodiversity in particular area, due to time limitation and presence of water in wetland habitat during wet season. The last survey period was considered suitable time as it was given the most likely data between the dry season and early wet season. Different habitat types and representative habitat sites were observed. Habitats of the study area were classified into degraded wetland and natural wetland habitat. Degraded wetland habitat was grouped into irrigation (crop production) area, coffee production area and grazing land habitat types.

Secondary data: Secondary data was collected by using questionnaire and interview. Sample respondents were randomly selected from the households registered as the residents of the selected village, since they are homogenous in their ethnicity, socio-economic characteristics, educational back grounds, religions and etc. Accordingly, 30% of household sample sizes from each selected 4 villages were drawn and a total of 132 households were randomly selected.

Table 1 Distribution of respondents by their kebeles

S/no	Kebeles	Villages	Household size(HH)	Sample size (30%)
1	Abichu Shogo	Sako	120	27.3
2	Mata	AgaloSako	80	18.2
3	Mata	Hamdo Chaka	140	31.8
4	Abichu Shogo	Koli	100	22.7
Total			440	100

Survey questionnaire: Selected sample households were interviewed using structured questionnaire. This was aimed to investigate the different uses of resources by local communities. This household survey was conducted on 132 sample households permanently

living in the villages. The major issues addressed in the questionnaire include socio-economic features of the households, means of the livelihood, and income generation, land sources and its utilization, wetlands crop and livestock production and value (importance) and threats of wetlands.

3.4 Data analysis

Data collected through different methods (quadratic method, questionnaires, and interviews) were analyzed and interpretation was conducted by quantitative and qualitative descriptions. It was analyzed by Simpson's diversity index, Simpson evenness index and Sampson's similarity index. This helped the researcher to make some generalization from the collected data. The whole wetland was analyzed using 10 transects and a total of 40 plots.

3.4.1 Species diversity analysis

Plant species diversity refers to the number of different species in a particular area (i.e. species richness) and their relative abundance (evenness) within a defined area. Diversity indices (DI) provide important information about rarity and commonness of species in a community. The ability quantify adiversity in this way was an important tool for biologists trying to understand plant community structure. Simpson indices were used to measure the species diversity (Magurran, 1988).

Simpson's Diversity Indices (D): Simpson's diversity index ranges from 0 to 1, with values near zero corresponding to highly diverse or heterogeneous ecosystem and values near one corresponding to more homogeneous ecosystems (Simpson et al., 1986). With this index, 0 represents infinite diversity and 1, no diversity. That was, the bigger the value of D, the lower the diversity.

D=$\sum(n/N)2$ or $D = \frac{\sum \boldsymbol{n(n-1)}}{\boldsymbol{N(N-1)}}$where, n: the total number of organisms of a particular species

N: the total number of organisms of all species.

The most common way of converting homogeneity into diversity is D Simpson=1/D. Simpson's evenness index (1-D) =$1 - D = 1 - \frac{\sum \boldsymbol{n(n-1)}}{\boldsymbol{N(N-1)}}$.In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

3.4.2 Species richness analysis

A simple way to calculate richness would be the number of species. It was the simplest measure of diversity and simply account of the number of different species in a given area. The number of species as per sample was a measure of species richness. The more species present in a sample was the richer the sample. Species richness is one of the most important elements in biodiversity because the number of species existing at a site was a quantitative measure of biodiversity and allows comparison with other sites (Hayat et al., 2010). Species richness was computed as the total number of species in each area.

$RI = \frac{S-1}{lnN}$ (Margalef's diversity index)

Where ln = natural logarithm

S= number of species in each habitat (the number of species recorded) and

N=number of individual in each habitat (the total number of individual in the sample).

3.4.3 Species similarity index

Species similarity was measured by using Simpson's similarity index. In reference to the composition of species, Simpson's similarity index (SI) would use to assess the similarity ofspecies between two different area (degraded and no degraded) and two different season. It was calculated by using formula: - $SI = \frac{2C}{A+B}$ where

SI= Simpson's similarity index

A= number of species that occur in site A.

B= number of species that occur in site B.C= number of species shared between A and B.

4. Results

4.1 Plant species Composition and Diversity in valley bottom Anfafi Wetland

4.1.1Plant species composition in degraded and natural Anfafi wetland

A total of 42 plant species were collected from all sample plots during this work. These plant species were found with different life forms. They were grouped into shrubs, herbs, trees and grasses. There were also perennial and annual crops and vegetables. Among these, 25 plant species were obtained from naturalAnfafi wetland sample plot.

From degraded valley bottom Anfafi wetland sample plot, a total of 21 plant species were collected. There were 6 plant species in irrigation area, 8 species in coffee area, and 7 plant species in grazing area. These plant species were also containing different life forms. These are shrubs, herbs, trees, grasses.

Table 2 Recorded plant species in natural Anfafi wetland

Site	Number of Sample plot	Speciename	Number of individual	Average	Percent (%)
Natural or no degraded wetland zone	*Ten Sample plot*	*Cyprus lactifolius*	937	93.7	57.1
		Cynodon dactylon	27	2.7	1.65
		Kotchya africana	11	1.1	0.7
		Erythrina abyssinica	3	0.3	0.18
		Cyprus ficheranus	340	34	20.7
		Abutilon mauritianum	2	0.2	0.12
		Scleria hispidior	21	2.1	1.28
		Pennisetum uliginosum	107	10.7	6.52
		Grewia ferruginea	86	8.6	5.24

		Rosa abyssinica	2	0.2	0.12
		Euphorbia petitiana	22	2.2	1.34
		Pennisetum macrourum	23	2.3	1.4
Natural or no degraded wetland zone		*Euphorbia abyssinica*	1	0.1	0.06
		Urtica simensis	6	0.6	0.37
		Commelina diffusa	9	0.9	0.6
		Albizia grandibracteata	2	0.2	0.12
		Hyparrhenia cymbaria	3	0.3	0.18
		Dracaena steudneri	1	0.1	0.06
		Cyperus digitatus	6	0.6	0.37
		Asparagus africanus	1	0.1	0.06
		Phytolaca dodecandra	1	0.1	0.06
		Oplismenus hirtellus	5	0.5	0.3
		Cyperus rigidifolius	15	1.5	0.9
		Pennisetum nubicam	8	0.8	0.5
		Setaria pumila	2	0.2	0.12
Total		25	1641		100

4.2 Plant species in natural valley bottom Anfafi wetland

With regard to plant species, natural valley bottom Anfafi wetland was mainly covered by *Cyprus lactifolius*, *Cyperus fischeranus*, *Cyperus rigidifolius*, and *Pennisetum uliginosum*.

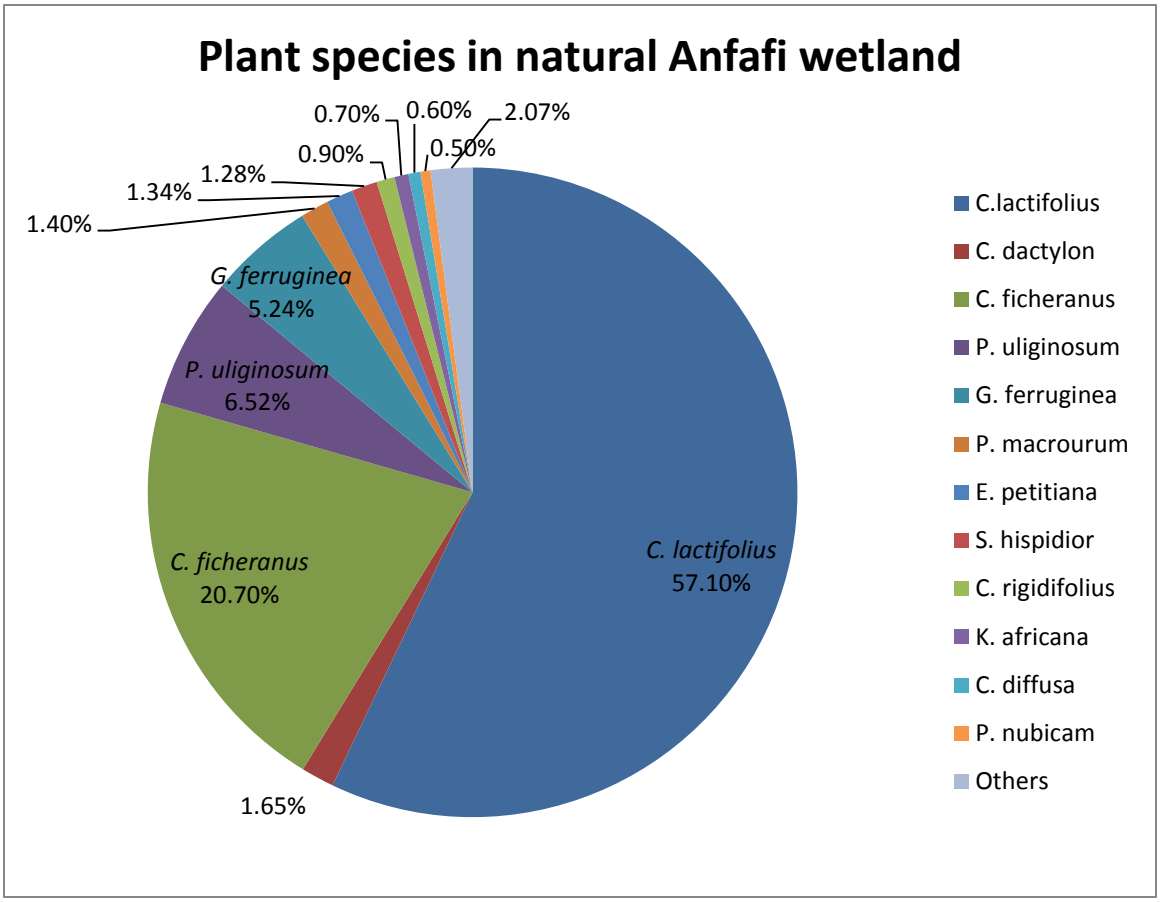


Figure 2the percent of plant species in natural wetland area.

Natural Valley bottom Anfafi wetland was contained different types of plant species. Large area of this wetland was covered by *Cyprus lactifolius (57.1%). Cyprus lactifolius* was locally known as "Caffee." *Cyprus ficheranus* was another common plant species in no degraded wetland area. It was the second dominant species (20.7%). *Pennisetum uliginosum* and *Grewia ferruginea* were covered by 6.52% and 5.24% respectively. *Cynodondactlon "Coqoorsa", Pennisetum macrourum, Euphorbia petitiana* and *Scleria hispidior have 1.65%, 1.4%, 1.34% and 1.28% respectively.* Another species were covered less than one percent in natural area of valley bottom Anfafi wetland.

4.3 Plant species in degraded valley bottom Anfafi wetland

4.3.1 Plant species in grazing area

Plant species in the grazing area of valley bottom Anfafi wetland were *Cynodon dactylon, Cyprus lactifolius, Coelachyrum poiflorum*and, *Pennisetum macrourum.* Grazing area of Anfafiwetland was mainly covered by grasses. *Cynodon dactylon* "Coqoorsa" was covered 75

percent of grazing area of valley bottom Anfafi wetland. *Cyperus lactifolius* (14%) was also the common species in grazing land. This area was also covered by *Coelachyrum poiflorum* with 6.1 percents. *Pennisetum macrourum* and *Cymbogogon ctratus* were found with 2.6% and 1.2% respectively. *Cynodon lemfuensis* and *Setaria pumila* were covered less than one percent.

Table 3Plant species in grazing wetland area

Site	Numbers of sample plot	Species name	Numbers of individual	Average	Percent (%)
Grazing land in wetlands	Ten sample plot	*Cyprus lactifolius*	79	7.9	14
		Cynodon dactylon	432	43.2	75
		Setaria pumila	1	0.1	0.2
		Cynodon lemfuensis	5	0.5	0.9
		Cymbopogon ctratus	7	0.7	1.2
		Pennisetum macrourum	15	1.5	2.6
		Coelachyrum poiflorum	35	3.5	6.1
Total		7	574		100

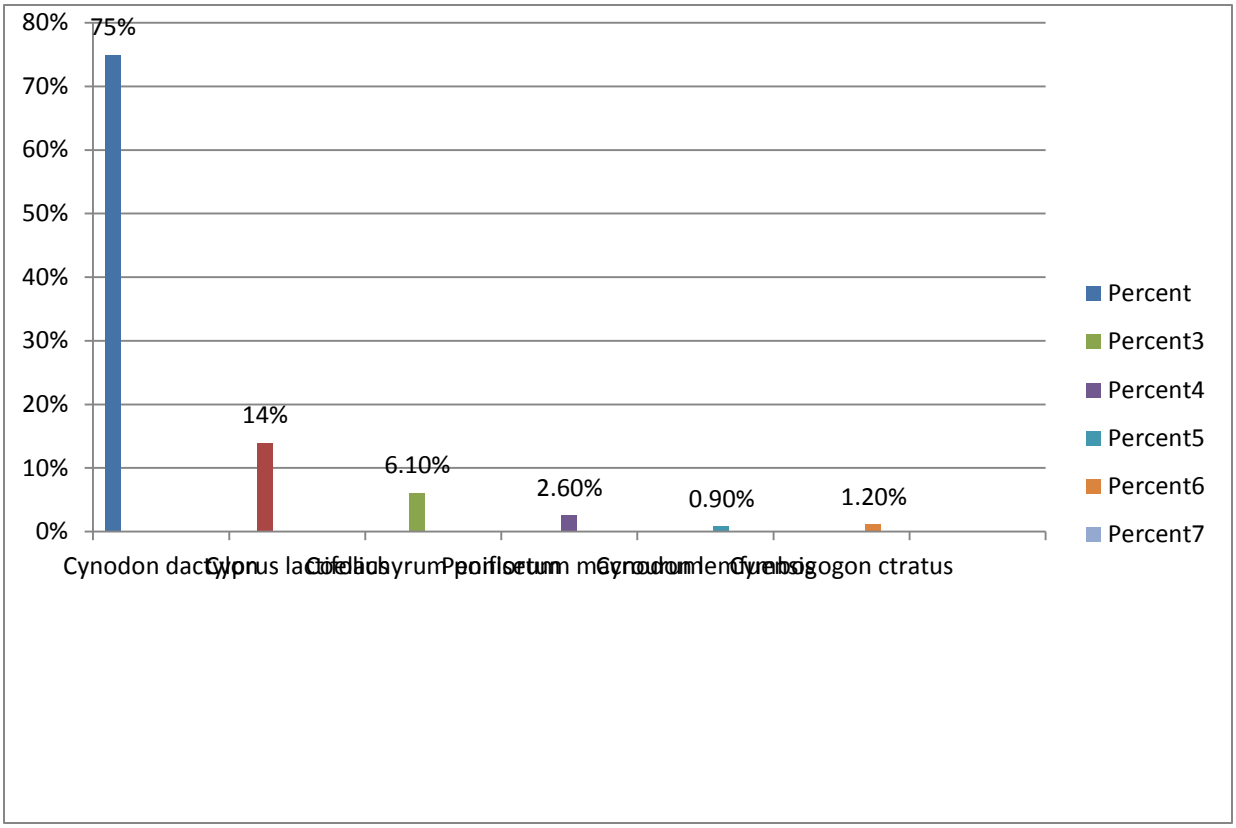


Figure3 Percent of plant species in grazing area of Anfafi wetland.

4.3.2 Plant species in coffee area of Anfafi wetland

Plant species found in coffee area of Anfafi wetland was *Coffea arabica*, *Justicia schimperiana*, *Vernonia schimperi*, *prunus africana* and *Gardenia ternfolia*. Trees make the largest proportion of the life forms (87.5%). *Coffea arabica* was the most dominant species in this area.

Coffee forest area of valley bottom Anfafi wetland was mainly covered by *Coffea arabica* "Buna" (96.03%). *Justicia schimperiana* (1.31%) was also the second common species. *Vernonia schimperi* (0.77%), *Prunus africana* (0.57%), *Vitex doniana* (0.28%), and *Pouteri adolfi* (0.19%) were the rare species.

Table 4Plant species in coffee area in Anfafi wetland

Site	Number of sample plot	Species name	Number of individual	Average	Percent
Coffee forest area	Ten sample plot	*Coffea arabica*	1015	101.5	96.03
		Justicia schimperiana	14	1.4	1.31
		Vernonia schimperi	8	0.8	0.77
		Croton macrostchyus	3	0.3	0.28
		Vitex doniana	3	0.3	0.28
Coffee forest area	Ten sample plot.	*Prunus africana*	6	0.6	0.57
		Pouteri aadolfi	2	0.2	0.19
		Gardenia ternfolia	6	0.6	0.57
Total		8	1057		100

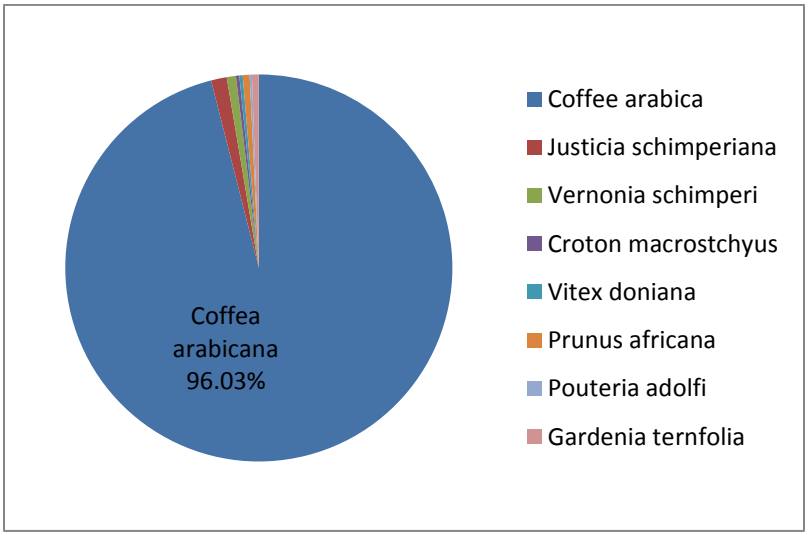


Figure 3Percent of plant species in Coffee forest area of Anfafi wetland

4.3.3 Plant species in irrigation area of Anfafi wetland

Plant species in irrigation area of Anfafi wetland was *Pennisetum longistylum, Zea mays, Allium cepa*, *Caosicum frutescens*, *Solanum tuberosum*, and *Brassica oleracea*. Irrigation area was completely dominated by crops and vegetables (98%).

Natural area of Anfafi wetland was mainly covered by *Cyprus lactifolius* and *Cyprus ficheranus*. This area was covered by trees and grasses with less percent. Irrigation site of valley bottom Anfafiwetland was completely covered by annual (*Zea mays*) and perennial crops (*Pennisetum longistylum*) and some vegetables (*Solanum tuberosum*). Grazing land of this wetland was maily covered by *Cynodon dactylon* and coffee forest area was mainly covered by *Coffea arabica*.

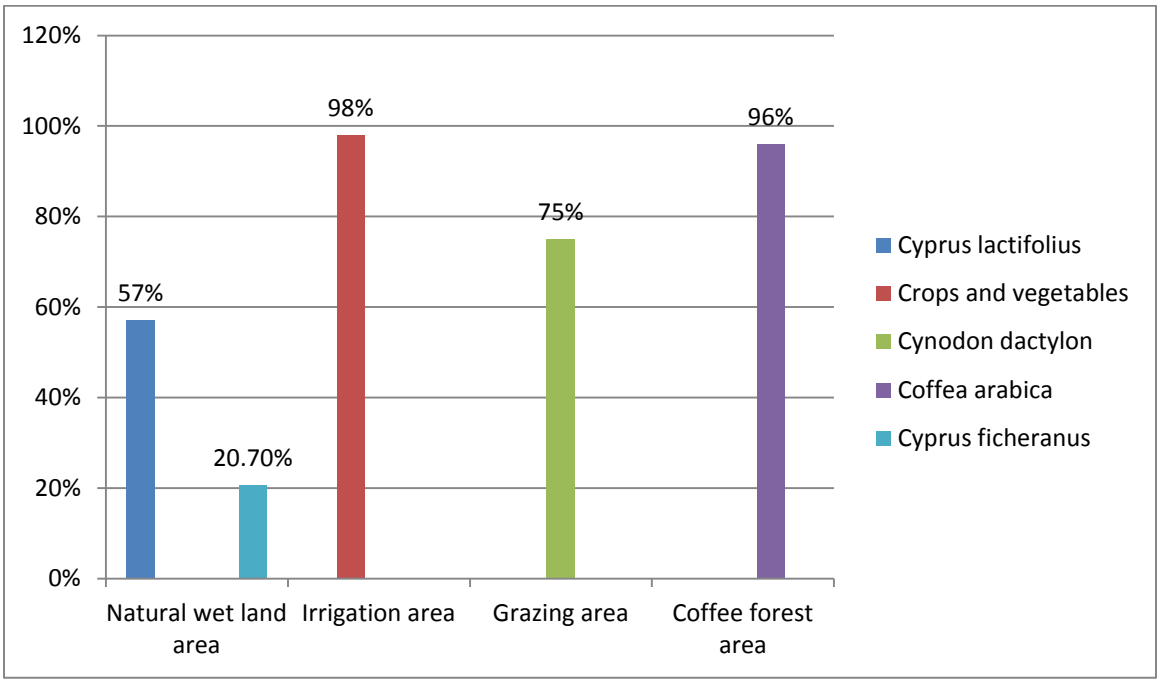


Figure 4Percent of plant species in Anfafi wetland (Source: Author Field survey, January, 2018)

4.4 Plant species diversity in natural and degraded valley bottom Anfafi wetland

4.4.1 Species diversity index

4.4.1.1 Simpson's Diversity Index (D) of plant species in natural valley bottom Anfafi wetland

Simpson's diversity index of all plant species collected sample from natural wetland was 0.38. Simpson's evenness index was 0.62**.**Species richness index of natural valley bottom Anfafi wetland was 3.24.

Table 5Species diversity index of natural valley bottom Anfafiwetland

Species diversity indices	Site
	Natural wetland area
Simpson's diversity index (D)	0.38
Species evenness (1-D)	0.62
Species richness (RI)	3.24

4.4.1.2 Simpson's Diversity Index (D) of plant species in irrigation area of Anfafi wetland

Simpson's diversity index of all plant species in the sample was 0.62.Simpson's evenness index of plant species in the sample was 0.38. Species richness was 0.85.

Table 6Species diversity index of irrigation site of wetland

Species diversity indices	Site
	Irrigation area/ degraded wetland area
Simpson's diversity index (D)	0.62
Species evenness (1-D)	0.38
Species richness (RI)	0.85

4.4.1.3 Simpson's Diversity Index (D) of plant species in grazing area of Anfafi wetland

Simpson's diversity index of plant species which recorded in grazing area of valley bottom Anfafi wetland site was 0.59. Simpson's evenness index of all plant species in the sample of grazing land was 0.41. Species richness was 0.94.

Table 7Species diversity index of grazing site of wetland

Species diversity indices	Site
	Grazing land/ degraded wetland area
Simpson's diversity index (D)	0.59
Species evenness (1-D)	0.41
Species richness (RI)	0.94

4.4.1.4 Simpson's Diversity Index (D) of plant species in coffee area of Anfafi wetland

Simpson's diversity index of all plant species of coffee forest area of valley bottom Anfafi wetland was 0.92. Simpson's evenness index of plant species was 0.08.Species richness of coffee forest area was 1.

Table 8Species diversity index of coffee forest site of wetland

Species diversity indices	Site
	Coffee forest /degraded wetland area
Simpson's diversity index (D)	0.92
Species evenness (1-D)	0.08
Species richness (RI)	1

4.5 Species similarity index

4.5.1Simpson's similarity index between natural and degraded Anfafi wet land

Simpson's similarities index of all plant species in the sample plot of valley bottom Anfafi wetland shows that the species in natural and degraded wetland area were similar only by 0.17. Plant species of natural and degraded wetland zone were similar only by 17%.

4.6 Comparison of plant species composition and diversity in natural and degraded site of Anfafi wetland

Simpson's diversity indexes were (0.38) in natural wetland, (0.59) in grazing site, (0.62) in irrigation site and (0.92) in coffee production site of wetland. Simpson's diversity index of natural wetland was approach to zero while Simpson's diversity index of degraded wetland area was approach to one. This result was expressed plant species in natural wetland was more diverse than degraded wetland site. There was only 0.17 similarity index between natural wetland and degrade wetland zone. This result was suggested that very small number of plant species were shared between two zones and shows that wetland ecosystem was disturbed by agricultural activity and other human activities.

Table 9Comparisons of plant species diversity

Species diversity	Natural wetland site	Grazing area in wetland	Irrigation area in wetland	Coffee production area in wetland
Simpson's diversity index(D)	0.38	0.59	0.62	0.92
Species evenness (1-D)	0.62	0.41	0.38	0.08
Species richness	3.24	0.94	0.85	1
Species similarity index between natural and degraded wetland area.	0.17			

4.7 Sample house hold character

As indicated under chapter3, the total sample size used in this study was 132 permanent households settling adjacent to valley bottom Anfafi wetland.

4.7.1Household size, age, and education

House hold size: They could be family members and other people living within the house hold for an extended period of the time. The survey result shows that the household's size ranges from 2-12 withan average of 8 persons.

Table 10House hold size of sample population

House hold	Frequency	Percent
1-4	30	22.7
5-8	48	36.4
9-12	54	40.9
Total	132	100

Age: Characteristics in termsof age were displayed in table11. About 84.8% household's respondents were within the age group of 18-60 years.

Table 11Respondent's age distribution

Age	Frequency	Percent
18-35	32	24.2
36-45	44	33.3
46-60	36	27.3
≥61	20	15.2
Total	132	100

Education: Education level of sample household may contain its own effect on their livelihood and awareness to conserve natural resources like wetland. More than 33.3 percent of households had no formal education. About 45.5% of the respondents attended primary education, 12.1 percent of the respondents attended adult education and only 9.1% of farmers were completed secondary school (see Table 12 below).

Table 12Educational status of sample household

Education level	Frequency	Percent
No formal education	44	33.3
Adult education	16	12.1
Primary education	60	45.5
Secondary education	12	9.1
Total	132	100

4.8 Wetland resource utilization

4.8.1 Agriculture land

The major source of livelihood of the people in the study area was crop and livestock production. The survey result indicated that more than 99% of the sample households were dependent on mixed farming. Both annual cops and perennial crops were grown in the study area. Livestock feed was crucial factor affecting livestock production. Wetland plants were served as the major source of livestock feed during dry and rainy season in the area. The survey result indicated that more than 74% of the sample households used the wetland resources as a source of food for their livestock, 8% of them were used their own grazing land, 12% were used common grazing land and 6% were used crop residue to feed their livestock.

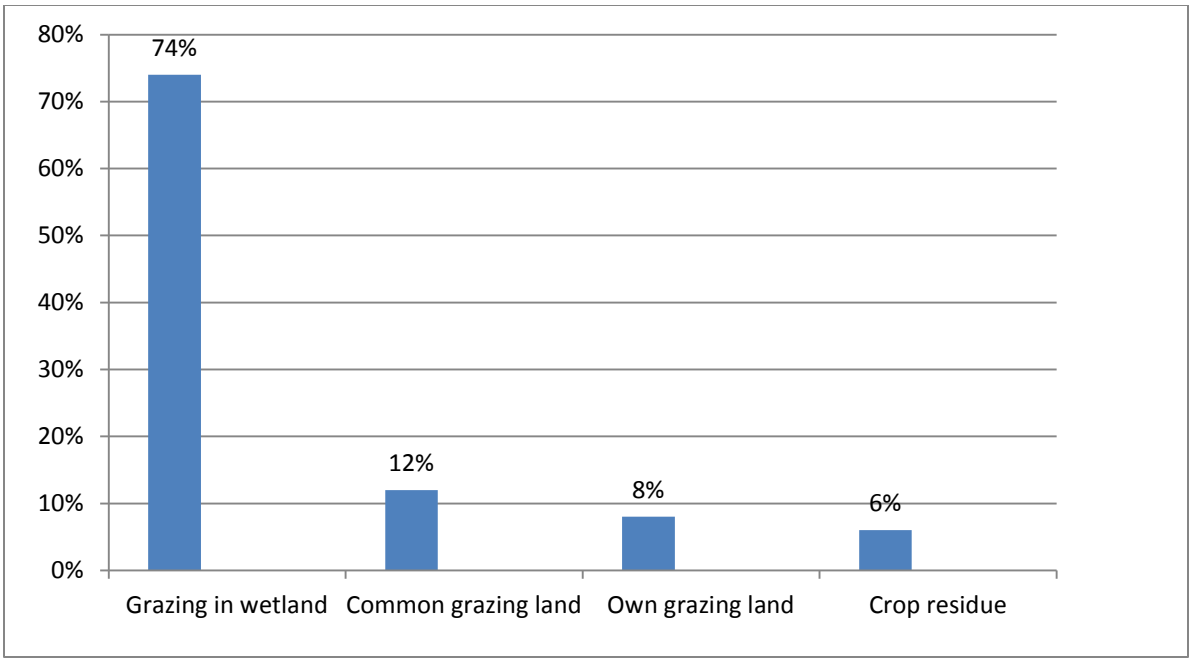


Figure 5Source of feed for livestock.

The size of farm land per household declined during the last 10 years from 2hectares to 1.2hectares in the area. The size of land allocated to crop and livestock production adjacent to the wetland and within wetland was declined due to increasing population pressure. Land was distributed by parents to the landless young farmers, resulting in small and fragmented farmland.

Table 13Area of land under different use system (hectare per household)

Land use type	2008	2018
Crop land	1.4	0.9
Pasture area	0.2	0.1
Woodland	0.2	0.1
Wetland	0.2	0.1
Total	2	1.2

The result of the study indicated that crop cultivated land was decreased from 1.4hectar to 0.9hectar between 2008 and 2018 due to population pressure. The size of pasture land, wood land and wetland were also decreased from 0.2hectar to 0.1hectar.

The study area farmers could give land, perennial crops and live stock as a gift to newly married sons, as a means of providing initial capital for new household. The respondents were asked how they obtained the land under their possession. About 92 percent of the sample respondent's accessed land through inheritance of the parents while some 8 percent accessed land through land transaction (share cropping, land renting and purchasing to access land).



Figure 6Area of land under different use system (hectare per household) decreased between 2008 and 2018.

5. Discussion

5. 1 Plant species in valley bottom Anfafi wetland

Natural valley bottom Anfafi wetland was mainly covered by *Cyprus lactifolius* and *Cyprus ficheranus*. They were made the largest proportion of the life forms. This was indicated that this area was not significantly disturbed by human activities. Grazing land (degraded) valley bottom Anfafi wetland was mainly dominated by *Cynodon dactylon*. As a result of over grazing in this area early existing vegetation was damaged. Furthermore, the decrease in water levels might allow grass land species to grow in wetland. This shows degradation of the earlier existing vegetation and decreasing of water level in wetland. There was agricultural activity within wetland. This irrigation area of wetland was completely dominated by annual and perennial crops. This indicates that earlier vegetation and natural wetland ecosystem was degraded by dry season agricultural activity and also other anthropogenic activities. For example, farmers who were lived around Anfafi wetland were used wetland plants for fodder and raw materials for construction. During irrigation activities, natural vegetation was removed from wetland surface and stored water was diverged along ditch. This activity was decreased water levels and directly affects earlier existed plant species in wetland. As a result of above mentioned activities the size of valley bottom Anfafi wetland was decreased and severely degraded. These results agree with Hefting et al., (2013) who reported agriculture was caused wetlands to dry out and lower water table levels. There was coffee forest within wetland and surround Anfafi wetland. The presence of *Coffea arabica* and other wood could be indicated that preexisting plant species and natural wetland ecosystem was degraded.

5.2 Valley bottom Anfafi wetland degradation

Simpson's diversity index of natural valley bottom Anfafi wetland was approach to zero. The result of this study was indicated that all plant species in natural wetland were more heterogeneous/ more diverse. The result of diversity index of degraded wetland zone was shown that less diversity or more homogeneous of this area. Simpson diversity index of irrigation area, grazing land and coffee forest site were approximately one (1). This value of Simpson's diversity index suggests that all plant species found in degraded wetland zone were more homogeneous/ less diverse because their values approach to one. Similarly, the result of Shannon-Wiener diversity index was indicated less plant species diversity in degraded valley bottom Anfafi

wetland. There are different plant species in both no degraded and degraded valley bottom Anfafi wetland except some species. The result of this study indicated that they are similar only 17% percents. This less similarity between the two sites suggests high degradation of some part of the wetland. The ongoing dry season agricultural activity in degraded wetland zone have resulted alteration of species composition because of it contribute conversion of wetland in to farm lands (irrigation area).

5.3 The main cause of valley bottom Anfafi wetland threats

5.3.1 Population pressure

Population of the study area was increased twice as compared with 10 years ago. This was resulted in expansion of agricultural land to feed the increasing population demand. The respondents were asked whether there is increasing in population growth or not in the area. They responded that if we compare the population number of the area before 10 years ago with that of today, high population number was observed today. As a result, the farmers are forced to find an extra farming land to feed their family. Survey result shows that Anfafi wetland was over exploited and under continual threat due to population growth. These result was agree with Abebe and Geheb (2003) who reports Ethiopian wetlands were lost by population pressure.

5.3.2 Irrigation

The conversion of wetlands for intensive irrigation agriculture, have emerged as a controversial development issues in recent years. This is particularly severed in the Anfafi area where water stresses critical during dry season. Moreover, irrigation was the most obvious response to water scarcity in agricultural areas. Water level of Anfafi wetland was decreased as result of dry season agricultural activities. This survey result was indicated natural ecosystem of Anfafi wetland and preexisting plant species were damaged due to irrigation activities. These results agree with Crafter (1993) who reported wetlands were lost or reduced in size through agricultural activities.

5.3.3 Coffee production

Valley bottom Anfafi wetland was found adjacent to coffee forest (production) area. Some households lived around Anfafi wetland was seedling coffee in wetland zone. They could generate income from coffee production. Coffee production was generated more income than other crop production. Due to this reason farmers could drain wetland, degraded early existing

plants and decreasing the size of wetland for coffee production. This survey result was indicated that Anfafi wetland was degraded due to coffee production around and in wetland zone. These result agree with Hailu (2003) who reports coffee production in Western Wollega was caused wetland degradation.

5.3.4 Livestock production

Livestock production was an integral part of the farming system in the study area. Livestock feed was supplied from green pasture, tree leaves and crop residues. The wetland serve as the major source of livestock feed both during the dry and rainy season. Grazing by domestic stock has also identified as threat to wetlands in addition to the above factors. This finding agrees with Gebresllassie et al., (2014) reports that grazing by domestic stocks was degraded wetland ecosystem. When grazing follow continuous cultivation; wetlands easily become degraded and loss their natural characteristics. Livestock trample the soil and compact it and destroys natural vegetation. They erode drainage channels leading to gullies and increase water out flow (Afework, 2003). These effects often result in the complete degradation of wetlands by reducing water table and by changing the original vegetation. The survey result indicated that more than 73percent of the sample households used the wetlands resource as a source of food for their livestock. This survey result shows that Anfafi wetland was degraded due to over grazing.

6. Conclusion and Recommendation

6.1 Conclusion

Plant species composition and diversity in natural (no degraded) Afafi wetland was generally high. There was alteration of plant species in degraded wetland due to dry season agricultural activities (irrigation) and other anthropogenic activities.The diversity index shows that plant species in natural wetland zone was more diverse than degraded wetland zone. This was because plant species in degraded wetland have been cleared due to expansion of farm land (irrigations). Irrigation area was dominated by crops like *Pennisetumlongistylum*, *Zea mays* and vegetables, grazing area was dominated by grasses and coffee production area was dominated by *Coffeaarabica*. Dominant plant species in this zone implies that wetland zone was unhealthy or degraded wetland zone. In natural or no degraded Anfafi wetland, species diversity is high and species were more heterogeneous. Natural wetland zone was dominated by shrubs and herbs, followed by grasses. The similarity (17%) between plant species in the natural wetland and degraded zone of Anfafi wetland was expressed unsustainable utilization of wetland resources. In degraded wetland zone earlier existing plant species degraded. The ongoing cultivation in the degraded Anfafi wetland has resulted in alteration of species composition because it involves conversion of wetland to irrigation land (farm land). There was shift in vegetation dominance between the two zones. Vegetation degradation due to agricultural activity and other human activities such as grazing, harvesting building material and fodder have been caused shift plant species dominance between the two zones. Diversity indices show that in degraded Anfafi wetland, the species were less heterogeneous and less diverse. This zone was dominated grassland species such as *Cynodondactylon* and perennial crops such as *Coffee arabica* and *Pennisetumlongistylum* and annual crop like *Zea mays*. With regard to plant species, the area was highly dominated by crops which could be a result of converting wetland to farm lands as well as other anthropogenic disturbances. The sample house hold survey result shows that Anfafi wetland was degraded due to agricultural activities such as crop and livestock production.

6.2 Recommendation

In order to reduce the threats of the wetlands and sustainable management and utilization of Anfafi wetland resources, the following recommendations are suggested.

- Ecological restoration of Anfafi wetland vegetation projects have to be developed and enacted specifically those focusing on natural regeneration of wetland plant species.
- Immediate control measure of dry season agricultural activities and prevent other negative anthropogenic activities.
- There is a need to educate the people on importance of conserving water sources for sustainable agriculture production. Public awareness has to be improved.
- There is a need to formulate local rules and regulation that support the existing environmental and wetland polices on conservation of water catchments.
- To safeguard the wetland resources degradation of the area, possible solution could be awareness creation on the environmental protection.
- The wetland resources of the study area are facing various anthropogenic factors, which drive the wetlands to degradation. Therefore, to manage and conserve the wetlands under the study in a proactive and sustainable way; there is a need for government to involve the local residents, knowledgeable individuals (indigenous knowledge) and other stake holders.

Reference

Abebe Y, Gheb K (eds) (2003). *Wetlands of Ethiopia*. Proceedings of a seminar on the resources and status of Ethiopian's wetlands, vi + 116pp.IUCN-Eastern Africa Regional office, Nairobi, Kenya.

Abunie, L. (1990). Distribution and Status of Ethiopian Wetlands: Overview, 37-44.

Aerts, R., Verhoeven,J.T.A. and Whigham, D.F. (1999). Plant mediated controls on nutrient cycling in temperature ferns and bogs. Ecology 80:2170-2181.

Alemayehu T (2006). Abstracts of the Founding Congress of the Ethiopian Association of Hydro Geologist (EAH). Addis Ababa.

Armentano, T.V. and Menges, S. E. (1986). Patterns of change in the carbon balance of organic soil wetlands of the temperate zone. Journal of Ecology 74:755-774.

Bernard, T., Mosepele, K. and Lamberg L. (2002).Environmental Monitoring of Tropical and Subtropical Wetlands.In preceding of a conference in Maun, Botswana, 4th-8thDecember, 2002.

Bruland et al., (2003).Effect of agriculture and wetland restoration on hydrology, soils and water quality of a Carolina Bay complex. Wetland Ecology and Management 11.141-156.

Bush, M. B. (2000). The ecology of changing Planet 2nd (Ed).Senauer Associates.Inc.Sunderland, Massachusetts, USA. 498pp.

Cowardin, Lewis M. (1979). Classification of Wetlands and Deep water Habitats of U.S. DIANE Publishing.

Dana, L. H. Popp, J.S. and Hyatt, E.D. (1998).Sustainability and resource Assessment. A case Study of Soil Resource in the United States.[http:// www.epa.gov/ ncea/pdfs].

De Laune et al., (1986). Nitrogen cycling in a fresh water marsh of Panicumhemitomon on the deltaic plain of the Mississippi river. Journal of Ecology 74:249-256.

Desta, Z., (2003). Challenges and opportunities of Ethiopian wetlands: the case of Lake Awassa and its feeders. P.67-76 in proceedings of a conference on wetlands of Ethiopia.

Dixon, A. (2008). The resilience and sustainability of local wetland management institution inIllubabor and Western Wollega, Ethiopia.Singap.J. Trop. Ecol. 29:341-346.

Due, M.J. and Anandajayasekam, P. (1984).Contrasting farming systems in Morogoro Region,Tanzania. Integrated inventory, assessment and monitoring of Tropical Wetland [http: //www.ees.ufl.edu /]

Dugan, J. Patrick (ed.), (1990). Wetland Conservation: A Review of Current Issues and Required Action. IUCN, Gland, Switzerland.

Dugan, J. Patrick (editor) (1993) Wetlands in Danger, World Conservation Atlas Series.

Ellis,F.(2000).Rural Livelihood Diversity in Developing Countries: Evidence and Policy Implications. Natural Resource Perspectives No40.Overseas Development Institute: London.

EPA-Ethiopian Environmental Authority (2004).Proceedings of the National consultative Workshop on the Ramsar convention and Ethiopia. March 18-19, 2004, Addis Ababa, Ethiopia.

EWNRA (Ethiopian Wetlands and Natural Resources Association (2008).Proceedings of the National Stakeholders. Work shop on Creating Nation Commitment for Wetland Policy and Strategy Development in Ethiopian, Ethiopian Wetlands and Natural Resources Association, Addis Ababa.

Finlayson, C.M. and Moser.M.(1992).Wetlands.Fact on file. Oxford.

Francois G. H. (2005). ECOSYSTEMS AND HUMAN WELL-BEING: WETLANDS AND WATER. Regions and Cohesion (Vol. 13).

Gebresllassieetal.,(2014). Wetland Degradation in Ethiopia: Causes, Consequences and Remedies. Journal of Environment And Earth Science, 4(11), 40-49. http://doi.org/2224 -3216.

Gell et al., 2013.Alegacy of climate and catchment change: The real challenge for wetland management. Hydrobiologia,708(1), 133-144. http://doi.org/10.1007/s10750-012-1163-4.

Hailu A (2003). Wetlands research in South Western Ethiopia: the experience of the Ethiopian Wetlands Research Programme. Wetlands of Ethiopia, P37.

Hefting et al., (2013). Wetlands in agricultural landscapes for nitrogen attenuation and biodiversity enhancement: Opportunities and limitations. Ecological Engineering, 56 (semptember 2011), 5-13.http://doi.org/10.106/j.ecoleng.2012.05.0011.

Hemond et al., 1988.Cumulative impacts on water quality functions of wetlands. Environmental Management 12 (5):639-653.

IWMI (2002). Sustainable management of wetlands in Southern Africa for poverty alleviation [http://www.iwmi.cgiar.org]

Jogo W, Hassan R (2010). Balancing the use of wetlands for economic wellbeing and ecological Security: the case of the Limpopo wetland in southern Africa. Ecol. Econ. 69:1569-1579.

Junk et al., (2013). Current State of Knowledge Regarding the World's Wetlands and their Future under Global Climate Change: A synthesis. Aquatic Sciences, 75(1), 151-167. http://doir.org/10.1007/s00027-012-0278-Z.

Kamukala, G,.l., and Crafter, S. A. (1993).Wetlands of Tanzania. In proceedings of the seminar on the wetlands of Tanzania.Morogoro, Tanzania, 27th -29th, November, 1993. 170pp.

Keddy, P.A. (2000). Wetland and Ecology.Principles and Conservation. Cambridge University Press UK. 614pp.

Kadlec.R.H. and Kadlec J.A. (1979).Wetlands and water quality. In: Greeson, P.E., Clark, J.R.and Clark, J,E. (eds). Wetland functions and values: the state of our understanding 436-456. American water Resources association, Minneapolis.

Leykun A (2003). The distribution and status of Ethiopian Wetlands: an overview, proceeding of a seminar on the resources and status of Ethiopia's wetlands, IUCN.

Maconachie, R.(2008).Decentralization and local institutional arrangements for wetlandmanagement in Ethiopia and Seirraleone.Applied Geography29:269-279.

Magurran, A.E. (1988). Ecological diversity and its measurement. Great Britain University Press, Cambridge UK.167pp.

Mclatchey, G.P. and Reddy, K.R. (1988).Regulation of organic matter decomposition and nutrient release in a wetland soil. Journal of Environmental Quality 27:1268-1274

Mereta et al.,(2012). Analysis of Environmental Factors Determining the Abundance and diversity of Dacroinvertebrate Taxa in Natural Wet lands of South west Ethiopia. Ecological Informaatics, 7(1), 52-61. http://doi.org/10.1016/j.ecoinf.2011.11.005

Mitsch, W. J. and Gosselink J. G. (1993).Wetlands.2nd Edn. Van Nostrand Rein hold, New York.

MNRT(2003). Assessment Needs for Wetlands Inventory and and Tools fo Assessing, Mapping Wetland Types and their Distribution Report. Government Printer, Dares Salaam, Tanzania.141pp.

MNRT(2004). National Wetland Strategy Wildlife Division Report. Government Printer, Dares Salaam, Tanzania. 198pp.

MNRT (2006). The National Wetland Management Strategy of 2007-2017. Ministry of Natural Resource and Tourism.

Mulatu et al., (2015). Socio-economic impacts of wetland cultivation in South-Bench, Southwest Ethiopia, 10(8), 840-848.http://doi.org/10.5897/AJAR2013.7992.

Mulugeta, S. (2004). Socio-economic Determinants of wetland cultivation in Kemise, Illubobor Zone, South western Ethiopia. Eastern Africa Soc. Sci. Res. Rev.20:93-114.

NCSU (2006).Sustainable Wetland Management. [http://www.Water.ncsu.edu].

Nichols, D.S. (1983). Capacity of natural wetlands to remove nutrients from waste water.Journal of Water Polution Control. 55: 495-505.

Ramsar Convention Bureau (1997). The Ramsar Convention Manual: A guide to the convention on wetlands (Ramsar, Iran 1971) 2nd edn. Ramsar Convention Bureau, Gland, Switzerland.

Richardson, C.J. (1985). Mechanisms controlling phosphorous retentions capacity in fresh water wetlands. Science 228: 1424-1427.

Rijsberman, F. and Sanjini, S. (2006).Sustainable Agriculture and Wetlands. [http:www.bio.uu.nl]

Simpson, R.L., Leck, M.A., Parker,V.T. (1989). Seed banks: General concepts and Methodological issue. In: Leck, M.A., Parker, V.T, Simpson, R.L. (Ed). Ecological of soil Seed banks. London: Academic Press, UK. Pp. 3-8.

Siraj, B. (2004). Wetlands of Oromia, their conservation and contribution to food security and Poverty reduction. Paper presented on proceedings of the National consultative work shop on the Ramsar convention and Ethiopia, March 18-19, Addis Ababa, Ethiopia.

Stolt et al., (2000). Comparison of soil and other environmental conditions in constructed and adjacent Palustrine reference wetlands. Wetlands 20:671-683.

Tesfaye H (1990). Wetlands and water birds in Eastern Africa. Proceedings of the IWRB Workshop in Uganda, 3-12 March 1990.

United State Environmental Protection Agency (2000). Water Quality Conditions in the United States. National Water Quality Inventory: 2000 Report. Ethiopia Protection Agency-841-R-02-001.

Wanbura, J.M.(2004). The Africa Water Bird Census in MinduDm and Mikumi National Park Report.Government Printer, Morogoro, Tanzania. 90pp.

WCED -World Commission for Environment and Development (1987).Our common future.WCED. Oxford University Press, New York, US398pp

Wood, A. (2001). The role and Importance of wetlands in Ethiopia. Proceeding of the WetlandsAwareness creation Work shop of the ANRS: January, 2001, Bahirdar, Ethiopia.

Wood et al.,(2002).Sustainablewetlandmanagement in Ilubabor Zone.Research Report Summaries.Hudders field, UK, Wetlands and Natural Resources Research Group, Hudders field University.

Zafirious, O.C., Joussot-Dubien, J., Zepp, R.g. and Zika. R. G. (1984). Photochemistry of natural waters. Environmental Science and Technology 18:358-371.

Annex1.

Households survey questionnaire.

Instruction**:**

1. This questionnaire refers to the household and should be administered with the head of the house hold male or female.
2. Before starting with the questionnaire/ interview, explain the purpose. The purpose of the questionnaire/ interview is to assess the impact of dry season agricultural activity on plant biodiversity of valley bottom Anfafiwetland and the ideas the community attaches to these resources. The opinion of the respondents on how to the resources are used and managed and the type of protection the (Governmental, nongovernmental, private, and local institutions) give will help to draw conclusion how the resources can be used in a sustainable manner /not.
3. All information give will be held confidential and will be used for academic purpose.

General information**:**

1. Enumerator
   1.1 Name of enumerator
   1.2 Signature of the enumerator ensuring completeness of the questionnaire and correctness.
   Sign_____Date_____
2. Identification of the respondent and household characteristics.
   2.1 zone_____Woreda_____Kebele_____
   2.2 Name of the household (respondent) or code_____
   2.3 Age of respondents (years)_____
   2.4 Sex of respondent (√): 1. Male 2. Female
   2.5 Education level completed by the respondent (√):
      A. No formal education B. 1^{st} cycle (1-4^{th} grade). C. 2^{nd} cycle (5-8^{th} grade). D. High school. E. Completed preparatory. F. Certificate. G. Diploma. H. Degree.

2.6 Current Marital Status of the respondents (√): A. Married B. Unmarried C. Divorce D. Widowed

2.7 Religion of the respondents (√) A. Orthodox B. Protestant C. Catholic D. Islam E. Others

2.8 What was your major occupation? I. Up to 2008. A. crop production B. Animal husbandry C. Mixed farming D. others.

II. At present time. A. crop production B. Animal husbandry C. Mixed farming D. others

2.9 How long did you live in this place? _____years.

2.10 Family size of the household by age and gender

Age	Male	Female	Total
18-35			
36-45			
46-60			
≥61			

Natural resource and use:

3. Wetland and wetland use system (crop and livestock production, water, wetland resources).

3.1 At present time do you have your own farm land? (√) [] Yes [ ] No

3.2 If your question number 3.1 is "yes", how did you get the land you are currently using? A. Recent government land distribution. B. Land distributed during the Derge regime C. Inherited from parents D. Shared from parents E.Rented F. Share crop G. Others.

3.3 Size of land owned by the house hold and its use (hectare).

S. no	Types of uses	Before 2008	Current year 2018	Reason for change between the two year
1	Total land owned			
2	Crop land			
3	Grazing land (own)			
4	Forest and wood land			
5	Wetland area			
6	Irrigated area			
7	No. of plots owned			

3.4 How do you perceive the trends in annual crop yield on the cultivated wetland currently? A. Increased B. Decreased C. Show no change

3.5 If your answer for question no. 3.4 is decreased, please reason out why? [ ] Yes [ ] No

3.6 Do you have livestock at your present holdings? [ ] Yes [ ] No

3.7 If your answer for question 3.6 is "yes" indicate the type of livestock you owned.

3.8 What is the major source of your animal feeding? A. Communal grazing land B. Crop residue C. Your own grazing land D. Grazing in wetland E. Grazing in forest

3.9 Do you have an additional (supplementary) income source? [ ] Yes [ ] No

3.10 If your answer for question number 3.9 is "yes" what are your house hold's means of income generation? A. Hand craft B. Livestock trading C. Selling forest product (fire wood etc.) D. Grain trading E. Employed and earn salary. F. Others.

3.11 Do you think the change observed in your income from different sources compared to before 10 years? [ ] Yes [ ] No

3.12 What is the land escape unit from which you obtain these income resources? A. Wetlands B. Forest land C. Farm land D. others (specify)

3.13 What types of raw materials you obtain from these resources? Grasses B. Fodder C. raw materials for construction D. Fuel wood E. Others (specify)

3.14 What is the major cause that insists the surrounding community to encroach to the wetland proper? 1. Farm land scarcity B. Lack of grazing land C. Lack of wetland awareness D. Deforestation E. Others

3.15 Do you benefit from Anfafi wetland? [ ] Yes [ ] No

3.16 If your answer for question number 3.15 is “yes”, what is your benefits or for what purpose? A. Irrigation B. Drinking water C. Livestock production D. Others.

3.17 Why do you like most living here (aroundAnfafi wetland)? A. Lack of land for settlement and livelihood B. Place were I born and live my family C. Easy access to resources D. Better living environment

Annex 2

Checklist for Interview

II. Cause of wetland depletion in the area

1. Do you think the settlement expansion to the area in the past time? A. Accelerated and resulted wetland destruction by clearing pants in to other land use B. Enhanced local people's needs of cutting plant for various purposes? C. According to your opinion, what are the major causes of wetland degradation in the area?
2. In your perception and observation does the settlers activity causes wetlands depletion in the area?
3. Which of the following factors do you think have been responsible for wetland degradation?

S.no	Factors	Degree of impact		
		No	Moderate	Severe
1	Intensive cultivation			
2	Over grazing			
3	Irrigation			
4	Raw materials for construction			
5	Others			

4. According to your indigenous knowledge and experience, what are the major changes have been observed on the area/ wetland recently?
5. If there is change in the major resources of Anfafi wetland catchments, please make list of specific change you have perceived on plant and water level?
6. What do you think the major reason for the shrinkage in the size of wetland area? A. Irrigation B. Over grazing C. Others.
7. How can these wetland resources be conserved/ saved?
8. What is expected from community?

Appendix 1: Plates



Plate 1: Recording plant species diversity in Anfafi wetland (Photo: Debela, January, 2018)



Plate 2: Natural Anfafi wetland (Photo: Debela, January, 2018)



Plate3. Grazing area of Anfafi wetland (Photo: Debela, January, 2018)



Plate4. Degrading wetland vegetation (Photo: Debela, January, 2018)



Plate5. Coffee forest of Anfafi wetland (Photo: Debela, January, 2018)



Plate6. Crops and vegetations in Anfafi wetland (Photo: Debela, January, 2018).

Appendix 2: Complete species list

Habitat	Vernacular name	Species name	Collected number
Natural or no degraded wetland zone	Caffee	*Cyprus lactifolius*	937
	Coqoorsa	*Cynodondactylon*	27
	Heennaa	*KotchyaAfricana*	11
	Walleensuu	*Erythrinaabyssinica*	3
	Dhalaaduu	*Cyprus ficheranus*	340
	Daannisa	*Abutilon mauritianum*	2
	Margagogorrii	*Scleriahispidior*	21
	Murii	*Pennisetumuliginosum*	107
	Laanqessaa	*Grewiaferruginea*	86
	Goraa	*Rosa abyssinica*	2
	Aannannookuruphee	*Euphorbia petitiana*	22
	Qamaxxee	*Pennisetummacrourum*	23
	Adaamii	*Euphorbia abyssinica*	1
	Doobbii	*Urticasimensis*	6
	Qorxobbii	*Commelinadiffusa*	9
	Koofalee	*Albiziagrandibracteata*	2
	Warqee	*Hyparrheniacymbaria*	3
	Afarfattuu	*Dracaena steudneri*	1

	Ashuffee	*Cyperusdigitatus*	6
	Hiddiisaree	*Asparagus africanus*	1
	Handoodee	*Phytolacadodecandra*	1
	Kaasii	*Oplismenushirtellus*	5
	Qunnii	*Cyperusrigidifolius*	15
	Muujjaa	*Pennisetumnubicam*	8
	Maxxannee	*Setariapumila*	2
	Caffee	*Cyprus lactifolius*	79
Grazing land in wetlands	Coqoarsa	*Cynodondactylon*	432
	Maxannee	*Setariapumila*	1
	Waraatii	*Cynodonlemfuensis*	5
	Citaa	*Cymbopogonctratus*	7
	Qamaxxee	*Pennisetummacrourum*	15
	Margahilleensaa	*Coelachyrumpoiflorum*	35
	Buna	*Coffee arabica*	1015
Coffee forest	Dhumuggaa	*Justiciaschimperiana*	14
	Dheebicha	*Vernoniaschimperi*	8
	Baddeessaa	*Croton macrostchyus*	3
	Gatamaa	*Vitexdoniana*	3

	QullubbiiDiimaa	*Allium cepa*	5
	Raafuu	*Brassica oleracea*	3
	Qaaraa	*Capsicum frutescens*	6
	Dinnicha	*Solanumtuberosum*	2
	Boqolloo	*Zea mays*	69
	Agadaashonkooraa	*Pennisetumlongistylum*	276