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Characterization of Gidabo River Sub Basin Wetlands: The Case of Warameda Wetland, Dale Woreda, Southern Ethiopia

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Abstract:
Wetlands are intimately linked with the ecological balance and socio-economic well-being of human population. Each wetland is composed of a number of physical, biological and chemical components such as soils, water, plant and animal species.. Processes among and within these components allow the wetland to generate, provide, perform and possess certain benefits, roles, importance and value to people, wildlife, natural processes and systems as a whole. Warameda wetland is among the famous and the largest wetland in the Dale Woreda. The aim of this research was therefore, to assess the wetland in terms of hydrology, pedology and biodiversity particularly fauna and flora resources. In order to undertake this study, focus group discussion, field observation and key informants were used to collect primary data. To investigate the characteristics of the wetland, Soil, vegetation diversity and hydrological survey was made. To identify the type and physical and chemical properties of the soil, soil samples were collected from the field and tested in laboratory. Relevant literatures and essential documents were also reviewed to generate the secondary data. The satellite image (SPOT 2006) was used to identify the land use classes and types of the wetland. Accordingly, two types of the wetlands were identified namely Surface and ground water dominated wetland and Precipitation Dominated wetland. The finding of the study shows that the wetland consists of species plants such as Vernonia auriculifera, Vernonia amygdalina, Cyperus latifolius, Leersia hexandra, Teclea nobilis, Syzygium guineense, Ficus sur, Premna schimperi, Maytenus obscura, Setaria megaphylla, Croton macrostachyus, Cynodon dactylon, Acanthus eminens, Phragmites, and Maesa lanceolata. Moreover, the wetland is drained by Raro River in the eastern part and waragalama springs in the western side. It is also fed by ground water. The soil types of the wetland that were identified through the laboratory test include Sandy Loam, Loam, and Loamy Sand and Clay loam. The ANOVA result of these soils indicates that there is a significant difference (P< 0.05) among the parameters of the soil PH, Sand, silt, clay and O.C at 95% level of confidence. Some of the fauna resources of the wetland include; hyena (Hyaenidae Carnivora), tiger cat (Felis Tigrina), Rabbit (leporidae cuniculas), pig (Artiodactyla suidae), porcupine (Hystricomorph Hystricidae), civet cat (Civettictis Civetta), aardvark (Oryteropus afer), duicker (Sylvicapra grimmia), fox (Cannis Vulpes), Rabbit (leporidae cuniculas) and colobus monkey (colobus guereza). The wetland is also home for several species of birds. The most common birds found in the wetland include : Cattle Egret (Bubulcus Ibis), Great White Egret (E.alba), Hammerkop (scopus uabretta), Hadada Ibis(Hagedashia hagedash),Spur-winged Plover(Vanallus spinosus),African Jacana (Actophilornis africanus), Egyptian Goose (Alopochen aegyptiaca), Yellow-Billed Duck (Anas undulata), Spot-breasted Plover (Vanellus melanocephalus), Rouget´s Rail (Rougetius rougetti),Grey Heron (A. Cinerea), Black-tailed Godwit(Liaosa liaosa), Black-winged Plover (Vanellus melanopterus), Little Egret (E.garzetta), Abdim's Stork (Ciconia abdimii), and Blue-headed Coucal, Abyssinian Ground Hornbill, Egyptian Vulture, Laughing Dove, Tawny Eagle, Wooly-necked Stork and Crowned Lapwing are some of the famous birds of the wetland.

Keywords: *wetlands, Hydrology, Pedology, Biodiversity*

1. Introduction

Under the text of the Ramsar Convention Secretariat, wetlands are defined as: "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"(Ramsar, 2006).Wetlands are becoming increasingly recognized as important natural resources because of their ability to fulfill a range of environmental functions and produce a number of products that are socially and economically beneficial to local communities (Dugan, 1990 and Silvius *et al.*, 2000 cited in Dixon and Wood, 2007).

Wetlands provide a large array of ecosystem services – defined as benefits people derive from nature. They are also used for farming, fishing, and livestock grazing (Lambert, 2003). They supply families with basic needs such as water, construction material, and fuel.

Wetlands also have considerable aesthetic, cultural, educational, and spiritual values and provide sustainable opportunities for recreation and tourism (Hategekimana and Twarabamenye, 2001; McInnes, 2010).

According to Dixon and Wood (2007), the abundance of water in the wetlands also supports the growth of dense sedge vegetation (*Cyprus latifolius*) 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.

In addition to these values, the system of interconnected wetlands play a crucial role by filtering pollutants and regulating water flows (influencing ground water recharge, flood impacts, and water availability during the dry season) (Emerton, *et al.*,1998; Trisurat, 2006; Hanson *et al.*,2008).

Wetlands are intimately linked with the ecological balance and socio-economic well-being of human population. Each wetland is composed of a number of physical, biological and chemical components such as soils, water, plant and animal species, and nutrients. Processes among and within these components allow the wetland to generate, provide, perform and possess certain benefits, roles, importance and value to people, wildlife, natural processes and systems as a whole (Choowaew; 2007)**.**

According to millennium Ecosystem Assessment (2005), Functions which are provided by wetland include groundwater recharge; groundwater discharge, flood water control, nutrient, sediment and contaminant retention; food web support; shoreline stabilization and erosion control; storm protection; and stabilization of local climate conditions, particularly rainfall and temperature. This type of wetland benefits is defined as "indirect use values" by economists.

Wetlands have abundantly diverse and varied resources. The list of harvestable products from wetlands exploited by humans is immense. The dynamic characters, especially the hydrological regime, of most wetlands, lead to the seasonal availability of resources, products and goods. Exploitation is being carried out at all levels of intensity from subsistence to cottage industries and commercial scale (Choowaew; 2007)**.** Harvesting that respects the annual and seasonal production rates, supportive and regenerative capacity of wetland species and ecosystems can generate great benefits to human society.

The water-saturated environment of wetlands supports a unique group of plants called "hydrophytes." These plants are adapted to grow in waterlogged soils (Ramsar Convention; 2002). In wetland ecosystem water is the primary factor controlling both the plant and animal life.

Animals in wetlands are among the most visible components of the ecosystem. They contribute a lot to the joy that humans derive from observing and experiencing wetlands. They also represent a lot of the staple food that wetlands produce, e.g., in the form of birds, fish (Oyugi and Iyango, 2007).

Wetlands provide many communities with a direct source of water for human and animal consumption, agriculture and industry. The storage of water in wetlands allows its later use as drinking water during dry seasons. Wetland edge springs are usually the only reliable sources of water both for domestic use and livestock, especially in the dry months of the year, when many streams dry up (EWNRA, 2003; Legesse 2008).

Apart from direct water supply, people benefit from the hydrological services of wetlands. The hydrologic regulation role of wetlands through receiving, storing and gradual releasing ensures surface and subsurface availability of freshwater resources essentially required for human and ecosystems needs. Wetland vegetation filters and detoxifies pollutants so that they improve water quality (Emerton, *et al.,* 1998).

In Dale woreda, there are many pockets of wetlands in different agro ecological zones. Most of them are small except Warameda which is large. Most part of this wetland is flooded during the summer season and dried up in dry season. Through many Rivers and other springs supply water for the wetland, Gidabo River is the main feeder of the wetland.

Therefore, in view of the above statements, the researcher is motivated to focus his study on characterization of the wetland in terms of hydrology, pedology and biodiversity.

The overall objective of this study was to characterize Warameda wetland in terms of hydrology, pedology and biodiversity particularly plants and animals

2. Materials and Methods

2.1. Background of the Study Area

The study was conducted in Dale Woreda, which is located between 6°27'00"- 6°51'00" N *latitude,* and 38°00'00" -38°37'00"E longitude in Sidama Zone, Southern Region of Ethiopia (Fig.2).This *Woreda* is one of the 21 *Woredas* in the Zone covering a total area of 1,494.63 km² (Kebede, 2010).

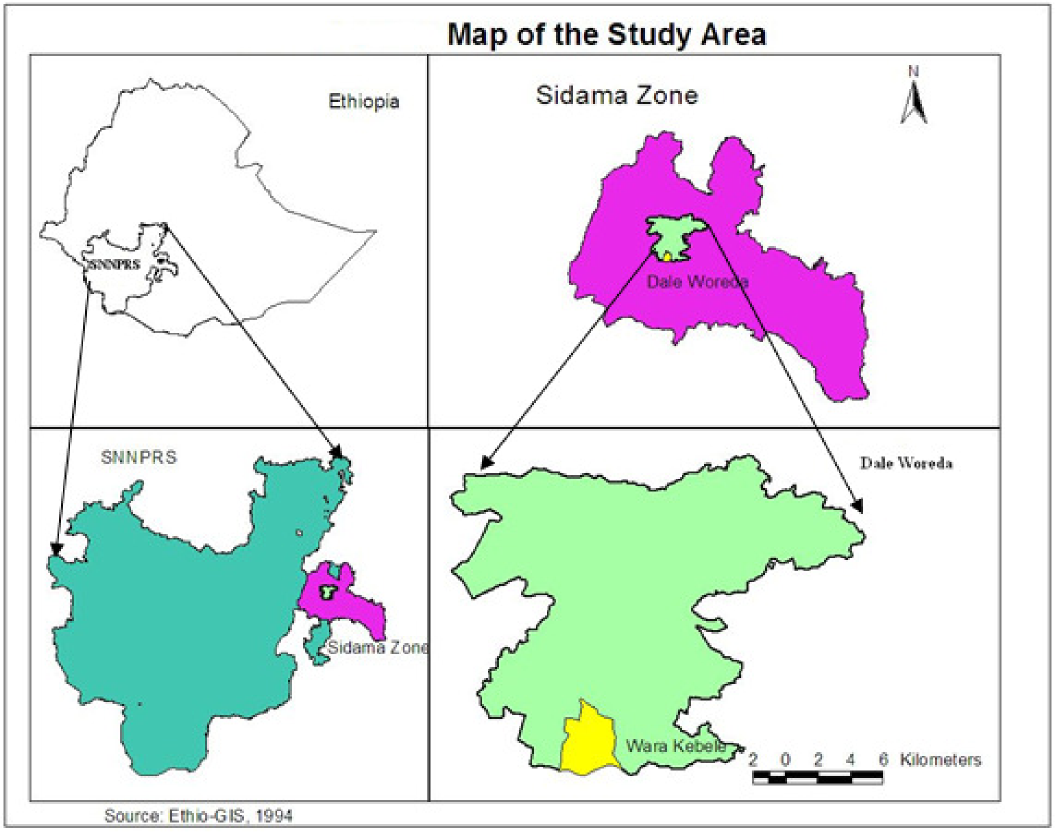

Figure 1: Location map of the study area

The study area is bordered by Boricha and Shebedino woredas in the north and North West; Loka Abaya woreda in the west; Aleta wondo wereda in the south, and Wonosho Wereda in the east and northeast. The capital, Yirgalem town is placed southeast of the main road from Addis Ababa to Dilla town, at a distance of 317 km from Addis Ababa, and some 42 km southeast of Awassa.

2.2. Drainage System

According to Kebede (2010), there are two main watersheds, Gidabo and Bilate and four sub watersheds in Dale woreda. Gidabo is the largest watershed in and around the study area covering a total area of 216,817.74 ha and comprising of four sub-watersheds. Bilate watershed is the second largest watershed in and around the study area. It covers a total area of 116,010.27 ha. Dama, Raro, Wamole and Woyima are sub-watersheds of Gidabo watershed each covering area of 8,170.56 ha, 5,580.72 ha, 16,938.72 ha and 4,678.11 ha, respectively.

2.3. Climate

The altitude of the study area ranges from 1800-2000m. This shows the relief feature of the woreda is mostly flat. The study area is largely found in the agro climatic zone, which is dominated by Dry Woina-Dega in the Western part and moist Woina –Dega in the Eastern part.

3. Methodology

3.1. Data Collection Methods

The primary data for this study was gathered through Questionnaire, Field Observation, Focus Group discussion, Key informant interview and Collection of some Biophysical parameters.

3.2. Collection of Biophysical Parameters

To investigate the characteristics of the wetland, three parameters were taken into consideration: Soils, vegetation diversity and hydrology. Two geologists were included in hydrologic data collection. The data collected by geologists were to check whether the ground water discharges or not the wetland. To investigate this, the discharge of the Raro River, which drains the wetland was measured both at inlet and outlet using the formula $Q= A_TV$. To sum up, hand-dung wells were measured to investigate the flow direction of ground water.

To identify the physical and chemical characteristics of the wetland soil, composite soil samples of 0-30cm depth were taken from surface and ground water dominated and precipitation dominated areas of the wetland. Nine composite soil samples were collected for laboratory analysis. The GPS readings of the coordinate systems and elevation of soil sample areas were displayed. The dominant plant species of the wetland were also identified on the field by botanist. Zoologists were also included to identify some of the birds and animals found in the wetland.

3.3. Secondary Data Collection

The data that were collected from secondary sources include related documents, studies, and other useful written materials needed for the study from internet sources, study reports, survey reports and other significant published papers.

Using GPS, satellite images, and topographical maps, the wetland types were identified in the field. Based on the results of the field observation, the wetland types were labeled and reproduced on a map using ERDAS 8.6 software. Accordingly, two types of wetlands were identified; precipitation dominated wetland and surface water and ground water dominated wetlands. Furthermore, the land use classes of the wetland were also identified.

3.4. Data Analysis

The qualitative data that were gathered through interviews, focus group discussion, key informant interview, and field observation were analyzed using content analysis by describing and interpreting the situation deeply and contextually.

Moreover, Statistical Packages for Social Sciences (SPSS) was used to analyze the lab result of the soil. This was applied to check whether there is a significance difference or not among the soil parameters by using ANOVA. The data gathered by botanists, geologists and zoologists were analysed based on basic information collected from the field.

4. Results and Discussion

In the investigation, emphases were been given to soils and hydrology, as well as biodiversity to characterize the Warameda wetland.
Using satellite image of SPOT 2006(System Pour 1'Observation de la Terre), the land use classes of the wetland were identified.
Accordingly five types of land use systems were identified.

Land use	Description
Cultivated land	Cultivated land comprising field plots used for production of both annual and perennial crops
Plantations	Areas covered with planted trees, mainly *Eucalyptus* and *Juniperus procera* at different heights, *Cordia africana,Aningeria altissima,Millettia ferruginea, podocarpus falcatus, Ficus sur,Ficus Vasta Syzygium guineense, Teclea nobilis, Croton macrostachyus*
Precipitation Dominated wetland	Areas that are waterlogged in the rainy season and relatively dry during the dry season. Used as supplementary grassland; a good source of grass for the dry season.
Settlement	Areas composed of small villages and/or scattered hamlets
Surface and ground water dominated wetland	Areas that are waterlogged, marshy and swampy in all seasons

Table 1: Description of Land use classes found in Warameda wetland

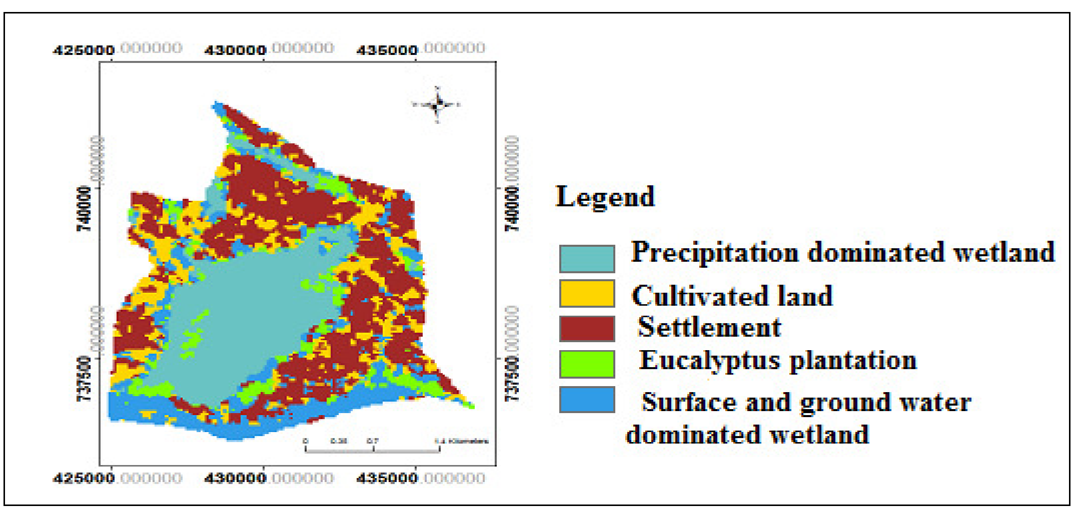

Figure 2: land use classes of Warameda wetland
Source: SPOT 2006

4.1. Hydrology

Generally, wetland hydrological systems involve the inflow and outflow of water through the wetland and their interaction with associated factors, such as hydrogeology. Hydrologic characteristics are important descriptors of wetlands, since the hydrological system varies among wetlands. They are extremely important for the maintenance of a wetland's structure and function, species composition and richness (Salum, 2007).

The wetland is drained by surface water like Raro River crossing the wetland in East west direction. At the western side, there are also springs with different discharge rate which discharge into the wetland. For example, Waragalama springs.

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by shallow water (Ramsar Convention Secretariat; 2006).

To understand the relationship of the wetland and ground water, the direction of shallow groundwater flow was checked by measuring water level in hand-dung wells located around the wetland (Fig.3). Moreover, the direction of spring discharge was also inspected. Both measurements and inspection revealed that groundwater is flowing toward the wetland.

From this point it can be concluded that piezometric head around the wetland was converging toward the wetland as it could be evidenced from static water level measured around the wetland. Furthermore, to check the above results; i.e. whether groundwater is draining the wetland or not, Raro river discharge measurement was made at the inlet (x), before entering the wetland, and at outlet near Challa Bridge(Y), as the river leaves the wetland .

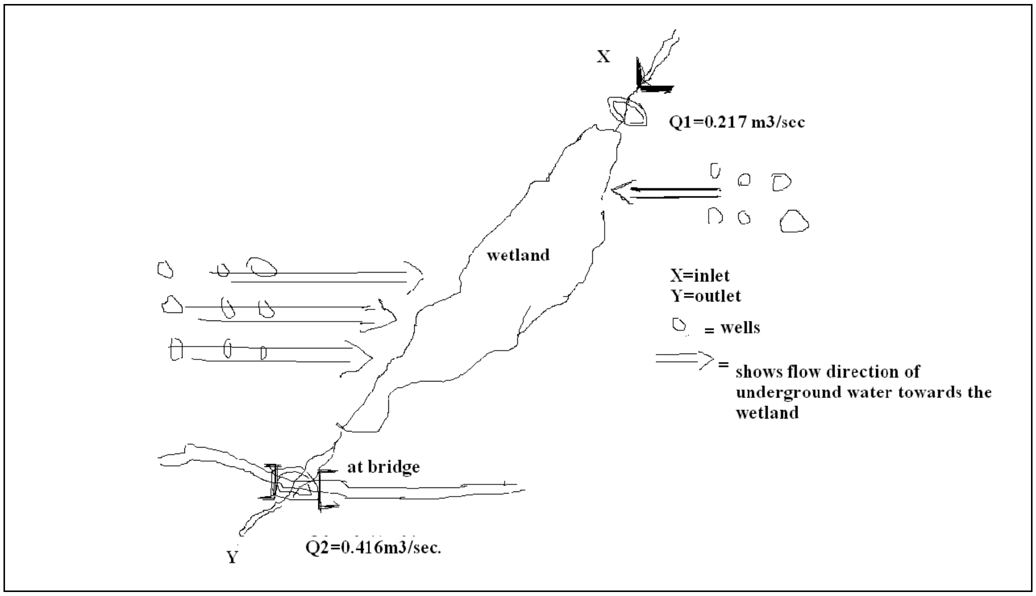

Figure 3: sketch showing the well location and site of discharge measurement

The following formula was used to calculate the discharge amount of the river at both inlet and outlet.

$Q= A_T V$ where Q = river discharge; A_T = crossectional area of the river channel;

V = velocity of the river water as it crosses the crossectional area at place of measurement.

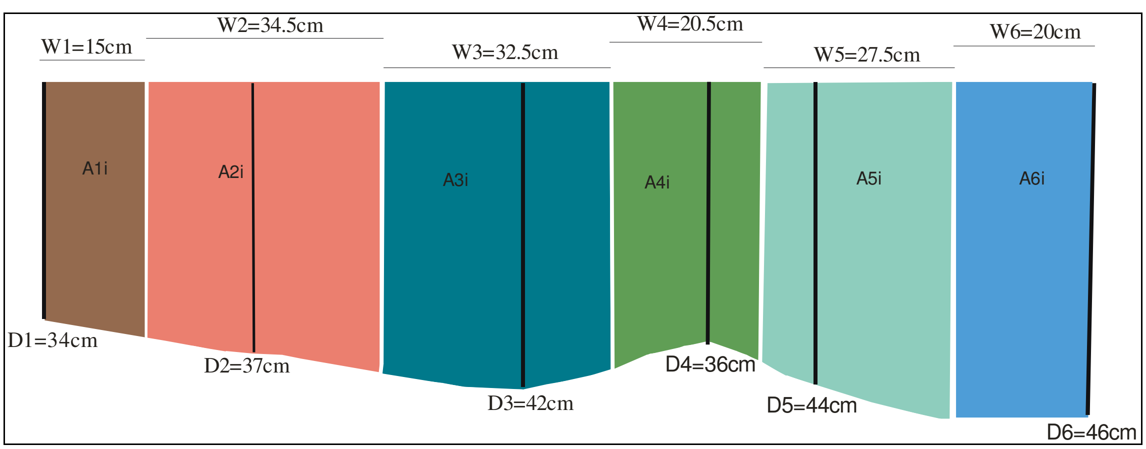

Figure 4: Channel cross-section at discharge measuring site (inlet)

Discharge at inlet, $Q_i = A_{Ti}V_i$; where $Q_{i\,=}$ river discharge at inlet; A_{Ti} = channel cross-section at inlet; and V_i = water velocity at inlet.
A_{Ti} = A1i+A2i+A3i+A4i+A5i+A6i
Where A1i = W1*D1 = 0.15m*0.34m = 0.051 m^2;
A2i = W2*D2 = 0.345m*0.37m = 0.128m^2;
A3i = W3*D3 = 0.325m*0.42m = 0.137m^2;
A4i = W4*D4 = 0.205m*0.36m = 0.074m^2;
A5i = W5*D5 = 0.275m*0.44 = 0.121m^2;
A6i = W6*D6 = 0.20m*0.46m = 0.092m^2
Accordingly, $A_{Ti\,=}$ 0.603m^2.

Velocity of the river water as it crosses the measuring site was estimated by floating method and accordingly Vi = 0.36m/sec.
Therefore, Qi = 0.603m^2 x 0.36m/sec.
= 0.217 m^3/sec.

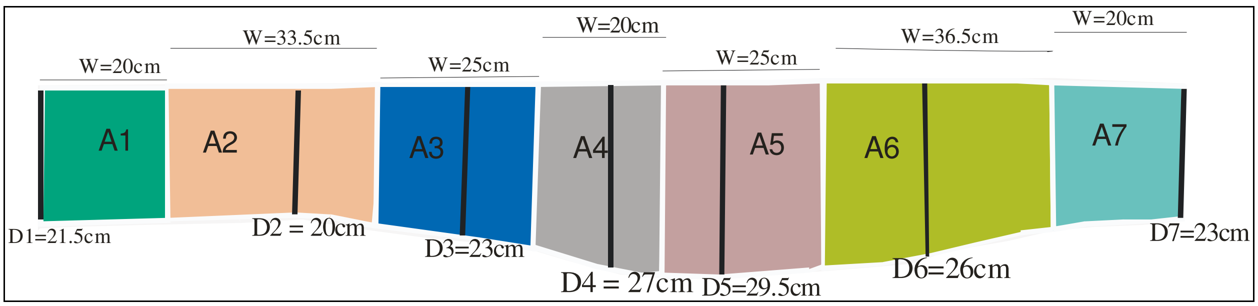

Figure 5: Channel cross-section at discharge measuring site (outlet)

Similarly, discharge at outlet, $Q_o=A_{To}V_o$; where Qo $_=$ river discharge at out let; A_{To} = channel cross-section at out let; and Vo = water velocity at outlet.
From figure 8:
A_{To} = A1+A2+A3+A4+A5+A6+A7
Where A1 = D1*W1 = (0.215m*0.2m) = 0.043m^2;
A2 = D2*W2 = (0.2m*0.335m) = 0.067m^2;
A3 =D3*W3 = (0.23m*0.25m) = 0.0575m^2;
A4 = D4*W4 = (0.27m*0.2m) = 0.054m^2;
A5=D5*W5 = (0.295m*0.25m) = 0.074m^2;
A6 =D6*W6 = (0.26m*0.365m) = 0.095m^2; and
A7 = D7*W7 = (0.23m*0.2m) = 0.046m^2
Hence A_{To} =0.436m^2
The river water is passing this cross-sectional area with average velocity (Vo) of 0.959m/s.
Therefore, Qo = 0.436m^2*0.959m/s
Qo =0.418m^3/sec.
Comparing the result of these measurements, Qi & Qo at both inlet and outlet, the discharge of the river at outlet is greater than that of the discharge at inlet (Qo>Qi). This reveals that additional water is gained between the stretches of the two measuring points. However, there is no other surface water, other than Raro River, is observed joining the system. Therefore, the only possible source is groundwater. That is, the wetland is drained by the surrounding groundwater in addition to Raro River. This result supported the conclusion made about direction of groundwater movement.

4.2. Pedology
Wetland supports farming because it provides the water required for irrigated crop cultivation, as well as depositing sediments and nutrients, which maintain soil fertility. They are also used for fishing, and livestock grazing. They supply families with basic needs such as water, construction material, and fuel (Tejuoso, 2006).
The laboratory analysis of the soil PH showed that the soils of the wetland are extremely acidic. The composite soil samples that were taken from precipitation dominated wetland coded as TW-SS_1, TW-SS_2 and TW-SS_3 have PH values of 5.6, 5.3, and 5.1 respectively. These soils have acidic property.
The composite soil sample of TW-SS_1 is composed of 41% sand, 29% silt and 30 % clay. The textural class of this soil is '*clay loam* 'which is recognized as high water holding capacity. It has 2.95 % of O.C content.
Likewise, the composite soil sample of TW-SS_2 contains 33% sand, 43% silt, 24% clay and 6.66% of O.C. This soil is texturally considered as 'loam 'which has medium water holding capacity. Moreover, the TW-SS_3 is made up of 41% sand, 37% silt, 22% clay and 3.23% O.C. Texturally, it is categorized under '*loam* '. Therefore, this soil has medium water holding capacity.

In similar manner, soil survey was also undertaken from surface and ground water dominated wetlands to investigate some properties of the soil. These soil samples that were taken from three sites are $PW\text{-}SS_4$, $PW\text{-}SS_5$ and $PW\text{-}SS_6$ with PH values of 4.7 , 4.4 and 4.8 respectively. Therefore, these soils are acidic in property. Likewise, their O.C content is 11.60%, 10.08% and 12. 37%, respectively. The percentage composition of these soils is 71% sand, 27% silt and 2% clay for $PW\text{-}SS_4$; 85% sand, 13% silt and 2% clay for $PW\text{-}SS_5$ and 81% sand, 17% silt and 2% clay for $PW\text{-}SS_6$. When we see the classes of these soils, $PW\text{-}SS_4$ and $PW\text{-}SS_6$ are '*sandy loam* 'where as $PW\text{-}SS_5$ is' *loamy sand'*. These soils have low water holding capacity.

Furthermore, soil samples were also taken under eucalyptus trees for laboratory analysis to determine the properties of the soils. The soil survey was taken from three sites coded as $E\text{-}SS_7$, E- SS_8 and E- SS_9. These soils have 2.66%, 2.57% and 2.19 % O.C respectively. The PH value of these soils are also indicated their acidic property. Their PH values are 4.9 for $E\text{-}SS_7$; 5.0 for E- SS_8 and 4.6 for E- SS_9.

The percentage composition of these soils are 41% sand, 33% silt, 26% clay; 43% sand , 29% silt , 28 % clay and 36% sand, 38 % silt, 26% clay for $E\text{-}SS_7$, E- SS_8 and E- SS_9 respectively. The $E\text{-}SS_7$ and E- SS_9 are texturally classified as 'l*oam* 'while E- SS_8 is '*clay loam* '. That means, $E\text{-}SS_8$ has a high water holding capacity where as $E\text{-}SS_{7\ and}$ E- SS_9 have medium water holding capacity.

Soil sample area of the Wetland	Field Code	P^{H-}Water	SAND	SILT	CLAY	Textural class	O.C
		1:2.5	%	%	%		%
Temporary	$TW\text{-}SS_1$	5.6	41	29	30	Clay loam	2.95
	$TW\text{-}SS_2$	5.3	33	43	24	Loam	6.66
	$TW\text{-}SS_3$	5.1	41	37	22	Loam	3.23
Permanent	$PW\text{-}SS_4$	4.7	71	27	2	Sandy Loam	11.60
	$PW\text{-}SS_5$	4.4	85	13	2	Loamy Sand	10.08
	$PW\text{-}SS_6$	4.8	81	17	2	Sandy Loam	12.37
Wetland under eucalyptus	$E\text{-}SS_7$	4.9	41	33	26	Loam	2.66
	$E\text{-}SS_8$	5.0	43	29	28	Clay loam	2.57
	$E\text{-}SS_9$	4.6	36	38	26	Loam	2.19

Table 2: Laboratory result of the soil test
Source: Field survey and soil laboratory analysis, 2011
TW – Temporary Wetland, PW - permanent Wetland, E- Eucalyptu, SS - Soil Sample

To check whether there is significance difference or not among PH , Sand , silt , clay and O.C of the soil, the lab result was analyzed using a computer soft ware program; Statistical Package for Social Sciences (SPSS). The summary of ANOVA indicated that, there was a significance difference ($P< 0.05$) among the five parameters of the soil at 95% level of confidence . This is because of the fact that F calculated in all cases is greater than the critical value of F.

4.3. Biodiversity

As it is pointed out by Mengistu ,(2008),located at the interface of water and land, wetlands are the world's most productive complex ecosystems, which provide critical nursery, breeding and feeding grounds for an array of biological diversity, both flora and fauna.

Similarly the wetland contains some vegetations, mammals and birds. However, due to unprecedented human interference many of the natural vegetations are lost. But, in some parts of the wetland only small numbers of less valuable vegetations by humans are remained. Some vegetation that we can find in and around the wetland are mostly man- made vegetation.

Wetlands are among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic material (Ramsar Convention Secretariat; 2006). In similar way, the wetland supports several species of plants, animal and birds as main habitat.

	Type of wetland	Examples	Dominant type of vegetations	Wild animals
1	Surface and ground water dominated wetlands	Marsh, swamp,	*Cyperus latifolius, Leersia hexandra, Cyperus distans , Cyperus mundtii, Premna schimperi, Setaria megaphylla , Acanthus eminens, Phragmites, and Maesa lanceolata, Ficus sur, Sesbania dummeri, Cyperus elegantulus, Cyperus flavescens, Cynodon dactylon ,Eragrostis tenuifolia,Typha aungustifolia, Prunus Africana, Flacourtia indica, Maytenus obscura*	hyena (*Hyaenidae Carnivora),* tiger cat *(Felis Tigrina),* , Rabbit *(leporidae cuniculas),* pig *(Artiodactyla suidae),* porcupine *(Hystricomorph Hystricidae),* civet cat *(Civettictis Civetta),* aardvark (*Oryteropus afer*), duicker (*Sylvicapra grimmia*), fox *(Cannis Vulpes),* Rabbit *(leporidae cuniculas)*
2	Precipitation dominated	Flood plain	*Croton macrostachyus, Cynodon dactylon, Flacourtia indica, Acanthus eminens, Maytenus obscura, Solanum incanum, Trifolium semipilosum, Senecio gigas, Prunus Africana, Syzygium guineense, Teclea nobilis,cordia Africana, Aningeria altissima, Millettiaferruginea, podocarpus falcatus*	fox *(Cannis Vulpes),* aardvark (*Oryteropus afer*), colobus monkey (*colobus guereza*), duicker (*Sylvicapra grimmia*)

Table 3: Some of the dominant plant and animal species of the wetland
Source: Field survey, 2011

Moreover, several species of birds also exist in the wetland. The most common birds found in the wetland include : Cattle Egret (*Bubulcus Ibis*), Great White Egret (*E.alba*) , Hammerkop (*scopus uabretta*), Hadada Ibis(*Hagedashia hagedash*),Spur-winged Plover(*Vanallus spinosus*),African Jacana (*Actophilornis africanus*) ,Egyptian Goose (*Alopochen aegyptiaca*), Yellow-Billed Duck (*Anas undulata*), Spot-breasted Plover (*Vanellus melanocephalus*), Rouget´s Rail (*Rougetius rougetti*),Grey Heron (*A. Cinerea*), Black-tailed Godwit(*Liaosa liaosa*), Black-winged Plover (*Vanellus melanopterus*), Little Egret (*E.garzetta*), Abdim's Stork (*Ciconia abdimii*), and Blue-headed Coucal, Abyssinian Ground Hornbill**,** Egyptian Vulture, Laughing Dove, Tawny Eagle, Wooly-necked Stork and Crowned Lapwing are some of the famous birds of the wetland.

5. Conclusion

The Warameda wetland is one of the prominent wetlands in the southern Ethiopia. It supports different fauna and flora resources as well some species of birds as habitat. The textural classes of the soil of the wetland are Clay loam, Loam, Sandy Loam, and Loamy Sand. Clay loam is the major textural classes of the soil..

The wetland is drained by surface water like Raro River crossing the wetland in East west direction. At the western side, there are also springs with different discharge rate which discharge into the wetland. For example, Waragalama springs. The wetland is also drained by the surrounding groundwater in addition to Raro River. This result supported the conclusion made about direction of groundwater movement.

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