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Perception-based Assessment of Ecosystem Services of Wetlands in Abijata-Shalla National Park in the Central Rift Valley of Ethiopia

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Abstract

Abijata-Shalla Park has been designated as one of Ethiopia's national parks to protect wetlands and Ecosystem Services (ESs) within the park's limits. Some of the ESs that are offered by the wetlands are currently depleting and disappearing rather than being protected. Understanding the drivers behind these changes can help individuals and policymakers design mitigation measures. The objective of this case was to assess ESs and the drivers of change with highlighting on the Abijata wetland. Qualitative and quantitative data were collected using household surveys, focus group discussions and field observations. Using these data, the various ESs were assessed and ranked from 1-10 according to local perception. Analyses of the study revealed that some of the ESs, including fish, papyrus, water reeds, hunting and spiritual services, existed before 1991, but have since disappeared from the site. Twenty ESs are available; 11 services pertain to provisioning, followed by 4 regulating, 3 cultural and 2 supporting services. Wetland for cultivation ranked highest, followed by domestic water supply and pasture. All services, with the exception of arable land and pasture, are on the decline. Water abstraction is the primary driver of ESs change, followed by population growth and deforestation. Water withdrawals from the Ziway-Shalla sub-basin should be restricted. Instead, focus on water conservation strategies to make better use of abstracted water.

Keywords: Wetland Ecosystem Services; Perception; Drivers of Change; Abijata Wetland; Abijata-Shalla Park

Introduction

Wetland ecosystems are the most productive natural ecosystems on Earth, next to rain forests. They are described both as "the kidneys of the landscape" because of the functions they perform in the hydrological and chemical cycles, and as "biological supermarkets" because of the extensive food chain and the rich biodiversity that they support.

Wetlands offer a wide range of benefits to humans. All the benefits that humans obtain directly or indirectly from ecosystem are considered as Ecosystem Services (ESs), which are described in the Millennium Ecosystem Assessment, MEA (2005) as provisioning, cultural, regulating and supporting services.

There is no universal definition of wetlands, various wetland scientists, countries, and an international treaty known as the Ramsar Convention (RC) all define them differently. The legal definition of a wetland is critical to the scientific understanding and the proper management of wetland systems in a country. Wetlands, according to the Ethiopian Water Resources Management Policy (WRMP), 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 saltwater, including areas of marine water the depth of which at low tide does not exceed six meters." As it appears, Ethiopia's WRMP defines wetlands in accordance with the RC [1].

As per the RC (1971) definition, Ethiopia has different types of wetlands, which have several socioeconomic and ecological benefits. Except for coastal and marine-related wetlands and extensive swamp-forest complexes, all forms of wetlands are found in Ethiopia. The "Water Tower" of Africa is often used to describe this country. So far, the country does not have any Ramsar sites. Of the countries bordering Ethiopia, Kenya has six sites, Sudan has three, and Djibouti and South Sudan each have one (www.ramsar.org).

The majority of Ethiopia's wetlands are located within the Rift Valley Basin. The basin is known for having huge water potential, which includes four sub-basins: Ziway-Shalla (Central Rift Valley, CRV Lakes), Awassa, Abaya-Chamo and Chew Bahir (Sissay, 2003). The Ziway-Shalla sub-basin or the CRV sub-basin of Ethiopia is an important region in terms of its enormous ESs and enriched biodiversity. The sub-basin, encompasses four major interconnected lakes in its rift valley, namely: Ziway, Langano, Abijata and Shalla. Lake Abijata and Lake Shalla together form Abijata-Shalla National Park (ASNP). The Ethiopian government established the park to protect wetlands and ESs within the park's limits.

As per the RC, wetland types can be categorized into five categories (marine, estuarine, palustrine, riverine, and lacustrine). The ASNP belongs to the lacustrine and riverine types. The lacustrine wetlands are wetland systems pertaining to lakes or lake shores, whereas the riverine wetland system is wetlands along rivers and streams. At the current research site, the wetland of Abijata and its feeder rivers. Local communities have benefited from the ecosystem goods and services provided by these types of wetlands.

Except for the wetlands mentioned above and some other known wetlands in the country, the wetland resources have not been fully documented. However, it is estimated that the country has more than 58 different types of wetlands, with an estimated area of 18, 587 km^2 (1.5-2%) of the total land mass of the country.

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Despite being the most productive ecosystems on the planet and providing numerous benefits to humans, wetlands are also the most threatened in the Earth's natural environment (The Intergovernmental Panel on Climate Change, IPCC, 2007). In both developed and developing countries, they have been destroyed at an alarming rate. Depending on the region, 30-90% of the world's wetlands have already been destroyed or heavily altered in many countries. They are also predicted to decline and disappear at a faster rate in the future, both in terms of area and quality.

In Ethiopia, the capacity of wetlands to provide ecosystem goods and services has been changing at a rate that is possibly historically unprecedented. As evidenced by various studies conducted by scholars from all parts of Ethiopia, Ethiopia's wetlands and the resources they provide have declined rapidly in recent decades, mainly as a result of anthropogenic activities being exacerbated by climate change [2].

The changes in wetland use systems to meet the demands of a growing population for farming, livestock grazing, and human settlement are inducing a shift in the socioeconomic and ecological functions of wetlands. Urban market forces are another major driving force. The ever-growing market for various Provisioning Services (PSs), including fish, fresh water, firewood, and other products like fruit and vegetable farming, are major drivers of depreciation. As per Tafa (2018), the growth of urban areas in the country contributes to deforestation, polluting the environment, and disposing of sewage and garbage into wetlands on the one hand, while simultaneously increasing demand for wetland products in urban areas and neighbouring countries on the other. There is extensive use of chemical fertilizers and insecticides to intensify wetland cultivation, which increases pollution as well as the discharge of sewage into wetlands. Especially since the large-scale farming sites are very close to the wetlands, they easily diffuse the various agrochemicals to the nearby wetlands and terrestrial areas, which can be easily drained into wetlands. Another pressure is rural unemployment. Rural residents rely on wetland resources to sustain their livelihoods as the rural population is growing faster than rural employment opportunities.

At the national level, Ethiopia has incorporated wetlands policy into its water resources, agriculture and environmental policies, but it does not have a national standing strategic plan or a specific wetland policy. The absence of a wetland policy and an accountable institution for addressing problems and the delayed ratification of the RC by the Ethiopian government have also contributed to the unrelieved conversion of wetland ecosystems and the degradation of their services. Kassa (2014) further claims that there is also no ESs use policy in the country (e.g., water use policy). This deficiency can lead to unregulated, unsustainable, or unlawful use of water and other wetland resources. For instance, the soda ash factory and upstream flower farm, which were established on the shores of Abijata and Ziway wetlands, have been extracting water from the wetlands with no restrictions.

A number of scholars have argued that Ethiopia's wetlands face many problems as a consequence of the failure to conduct Environmental Impact Assessments (EIA) prior to development projects. The construction of mechanized irrigation systems are good examples. The degradation and loss of wetlands are also exacerbated by the public ignorance of the value of wetlands (they are free and no one owns them) and insufficient recognition of the vital importance of the services that wetlands provide to human well- being (Giweta & Worku, 2018), the low involvement of local communities in wetland conservation and management (Wondie, 2018; Elias et al. 2019), and local villagers have no incentive to protect them (Dechasa et al, 2019). Scholars (e.g., Gebresllassie et al, 2014; Seid, 2017; Elias et al. 2019) have noticed that Ethiopians are not adequately responding to the loss and degradation of their wetlands [3].

The wetlands in Abijata-Shalla Park, which have contributed significantly to Ethiopia's economic development and the livelihoods of local residents in the sub-basin, are rapidly deteriorating despite their status as a protected area. Not only do the surface areas of the wetlands fluctuate year to year, but so do the quality and quantity of the ecosystem goods and services they offer. Abijata Wetland (AW), part of the ASNP in Ethiopia's CRV sub-basin, is among the most threatened ecosystems, and its goods and services are being destroyed. It is predicted that the wetland of Abijata will be completely used up in the next 20 to 50 years if pressures in the CRV sub-basin continue as usual. Hence, it is crucial to understand the drivers behind the changes in the wetland of Abijata and its ESs in order to design interventions that take into account positive impacts and minimize negative impacts. In the MEA (2005), a "driver" refers to any factor that changes an aspect of an ecosystem. In this study, factors that influence AW and its associated riverine system and their services.

The researchers' motivation was to establish a general background and provide science-based information on the wetlands and their ESs for conservation purposes. Our research centred on the following questions: What ESs are currently provided by the park's wetlands? What trend has been witnessed in the availability of ESs historically, pre-1991 and after? What are the drivers for the change?

Materials and Methods

Study area

The CRV sub-basin of Ethiopia is part of the Great African Rift Valley and lies between 38°00'-39°30' E longitude and 7°00'-8°30'N latitude. The area has an arid to semi-arid climate, although the highlands on the eastern and western escarpments of the valley are sub-humid. The sub-basin is endowed with a significant number of wetlands, which could contribute to the social, economical, and ecological development of the country. At the same time, the CRV is one of the most environmentally vulnerable areas in Ethiopia [4].

The park is located within the Ziway-Shalla sub-basin, part of the Ethiopian CRV. The sub-basin includes Lake Shalla and Lake Abijata, separated by 3 km of mountainous land. Together, they form the ASNP. The park was established in 1970 to protect endemic and endangered wildlife and aquatic birdlife as well as the two lakes and surrounding acacia forests. There are two types of ecosystems within the park: aquatic (482 km^2 covered by lakes, including Abijata and Shalla) and terrestrial (405 km^2).

In addition to the two lakes, the park has numerous associated hot springs and rivers around the catchments. There are two main rivers: the Bulbula and the Hora Qello River, which both feed Lake Abijata from Lake Ziway and Lake Langano, respectively. Two other rivers, Jido and Dedeba, flow into Lake Shalla, especially during the rainy seasons. Shalla Lake is the deepest lake in the Ethiopian Rift Valley, with a maximum depth of 266 m.

The park offers habitat for wildlife and has served as a wintering site and maintenance station for a large number of birds, including species native to Southern African, Sub-Saharan, and Palaearctic species. As a result, the park became one of the most popular tourist destinations in the country. It was proposed by Birdlife International to be a potential Ramsar wetland and a UNESCO World Heritage Site.

The altitude of the park ranges from 1540 to 2075 m.a.s.l., with the highest peak being Mount Fike, which is situated between the two lakes. It is 200 km from Addis Ababa. Administratively, the area shares fall between the East Shewa (Adami Tullu and Jido Kombolcha, ATJK district- North) and West Arsi zones (Arsi Negelle, AN district- South, and Southeast and west) of the Oromiya regional state (Figure 1). The Hora Kalo river constitutes a boundary between the two districts.

The climate of the ASNP is semi-arid for most of the year, with the rainy season between June and September, the dry season from October to February, and a small rainy season in between. The region receives annual precipitation varying from 500 (Langano Lake Weather Station) to 700 mm (Ziway Lake Weather Station), with a mean annual temperature of 20°C.

Sample Frame and Sampling Techniques

A sample frame for this study included all household heads over 30 years of age, living in or around the wetland periphery, and dependent on wetland goods and services.

A multistage sampling procedure was used to identify the heads of households from whom the data were collected. At the first stage, ASNP was chosen due to the fact that, despite being the only national park in Ethiopia established to protect wetlands, it was and remains one of Ethiopia's most endangered sites, which needed an urgent solution. In the second step, two districts that share a boundary with the park's ecosystems were selected. Within the park, wetlands shared 85% and 15% of their boundaries with the AN and ATJK districts, respectively (Figure 1). After consulting with agricultural extension experts from the two districts, the Kebeles (the lowest level administrative units in Ethiopia) located inside or on the periphery of the park and heavily dependent on the park's wetland resources as a source of livelihood were selected in the third stage. Hence, four Kebeles (*Shalla Bila, Mude Arjo, Daka Dalu Haran Gama and Gale Kelo*) from AN and two Kebeles from ATJK (*Desta Abijata and Adansho Boranota*) were selected purposely based on their adequate security for data collection, accessibility for fieldwork, and closeness to the park headquarter. In all, six Kebeles were included in the study. A total of 346 household heads were randomly selected from selected Kebeles based on a probability proportional to their size. A more rigorous, scientific method was used to determine the sample size. This was in order to ensure an approximate representation of the sample. The sample size was calculated using Kothari's (2004) sample size determination. As a result of incomplete data from some of the respondents, the response rate for the study was 98% of the 346 responses expected. The household survey took place from July 2020 to September 2020.

Data Collection

In addition to structured interviews (questionnaires), Focus Group Discussions (FGD) and direct field observations were used to collect the primary data. The cross-sectional survey was conducted by data enumerators (after they were trained in data handling), while the participatory methods were carried out by a researcher to validate the survey results. Both the household survey and the participatory methods were conducted in Afan Oromo, the local language.

For the household survey, and FGDs, 1991 served as a reference or benchmark year. The reason is that this year marks the period after the fall of the Dergue Regime, when the Federal Democratic Republic of Ethiopia (FDRE) comes into power. This allows households to easily memorize trends in changes in ESs and possible drivers of past changes. In order to gain a historical perspective on long-term changes in ESs, only community members over 30 years of age were interviewed. The target groups are presumed to have a greater understanding and can provide historical experiences.

Surveys of households and group discussions were conducted using a pre-tested semi-structured questionnaire. Questions addressed the current state of the wetlands in the park in terms of the key ESs that local communities obtain from the wetlands, drivers of change, and perception and knowledge of households regarding the existence and disappearance of ecosystem goods and services, pre-1991 and after 1991. Survey questions on wetland ESs were developed based on the wetland ESs identified by, with some conceptualization of the research site.

The list of ESs extracted from the household survey was verified through FGDs. A FGD was conducted in each Kebele with six to eight individuals of both sexes. In all, six FGDs were conducted in order to verify the results of the household survey and to hear the voices of indigenous communities. Participants in the focus groups were selected with the assistance of local leaders and Development Agents (DAs) based on their knowledge of and reliance on wetlands. The FGD comprised local leaders, healers, DAs, as well as the park's management [5].

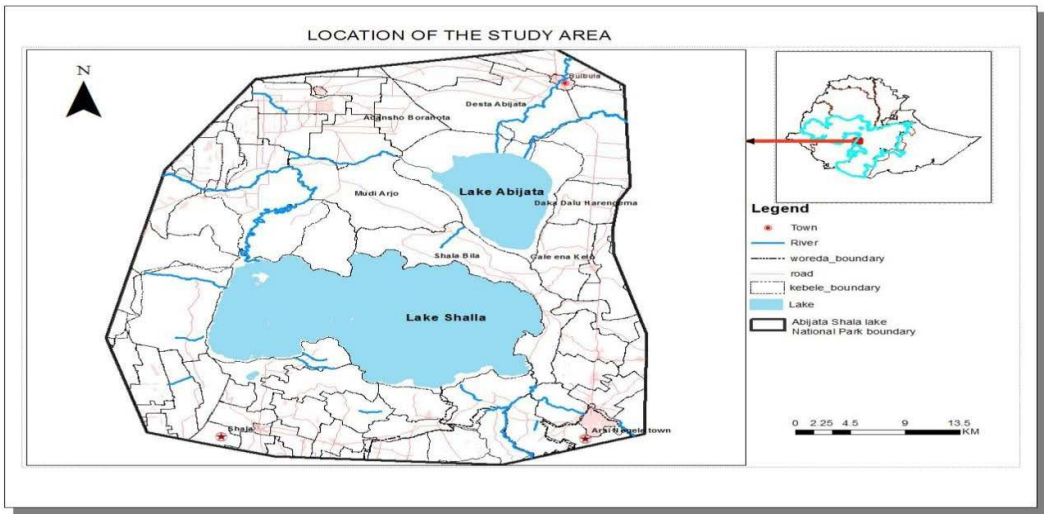

Figure 1: Location of the study area.

Moreover, field observations were made at two separate times. The first round of fieldwork took place during the pilot study and was important for a better understanding of the physical setting of the study area, the accessibility of Kebeles for fieldwork, and their proximity to the wetlands of the park. A second in-depth field observation was conducted during the data collection period by walking through the wetlands, Kebeles, as well as having informal discussions with local inhabitants. The observation serves as a reality check.

Data analysis

Both qualitative and quantitative data analysis methods were employed to analyse the collected data. The Statistical Package for Social Science (SPSS) 20.0 was used to analyse the quantitative data. The socio-demographic characteristics of the respondents and the rankings of the determinants of ESs change were described using descriptive statistics. A rating scale of very high (5), high (4), medium (3), low (2), and very low (1) was used to analyse the drivers of ESs change.

The data from the focus groups was analysed using qualitative data analysis. The data generated from the group discussions was first categorized and coded in line with the study questions (for example, the key ecosystem goods and services provided by the wetlands, and their changes over time; the existence and disappearance of ecosystem goods and services; potential drivers of change, etc.). Following that, themes with similar codes were grouped together.

The top ten most important ESs that the local villagers gain from the park wetlands were determined using FGD participants. Initially, participants in group discussions (each group had six participants) were asked to list key ESs derived from the wetlands. Participants were again asked to rank the listed ESs on a scale of 1 to 10, with 1 being the least preferred and 10 being the most preferred. The ranking order from most preferable to least preferable was determined by summing up the individual marks given for each service and divided by the number of respondents. Thirty-six respondents participated in this case. The participants' views on the economic and environmental benefits of each service were used to assign rankings.

Results and Discussions

The socio-demographic characteristics of the respondents

Of the 339 respondents, 79% were male household heads, while (21%) were female. The majority of respondents (72% of them) live inside the park, while the remaining (28%) live near its perimeter. The average age of respondents was 47.6. The majority of them (91%) were married. While (7%) were widowed and the divorced category constituted (2%). Among household heads, 58% did not attend any formal education. Only 8% of the respondents stated that they could only read and write. About (21%) of respondents had completed primary education. Those with a secondary education made up (10%) of the sample, while (3%) had attended a higher education [6].

The research region, just like the entire country, is dominated by rain-fed agriculture, with (96.5%) of respondents reporting farming that is totally reliant on rainfall; the remaining (3.5%) reported farming using mixed irrigation and rain-fed methods. On average, survey respondents owned 1.95 hectares of land. Indeed, nearly half of the ATJK respondents (47%) had one hectare or less. The majority of these respondents (72%) lack a land use or ownership certificate.

Ecosystem Services Assessment

Assessment of ESs prior to 1991

Local residents were asked for a list of ESs available before the fall of the Dergue regime in 1991. Through household surveys and group discussions, we identified 25 key ESs in the ASNP wetlands. Among them, 15 services belong to the provisioning category, followed by regulating and cultural services (4 for each) and supporting services (2) (Figure 2). The classification of ESs follows the MEA 2005 report; Mitsch & Gosselink, 2015).

Changes of Ecosystems and their ESs Prior to 1991

As determined by the FGDs, the park's wetlands were reached before 1991 in ESs and biodiversity. One of the park's resources, the AW, provided the area's inhabitants with food and income through food production and fishing. The wetland once contained many fish, including tilapia (*Oreochromis niloticus*), which was an important source of animal protein for the locals. During the FGD, participants highlighted the following:

"We shouldn't forget the noble use of fish in our lives during the 1983-1985 famine that took place in the country. Many surrounding communities have used wetland products, particularly fish, as safety nets to cope with the stresses caused by drought at that time."

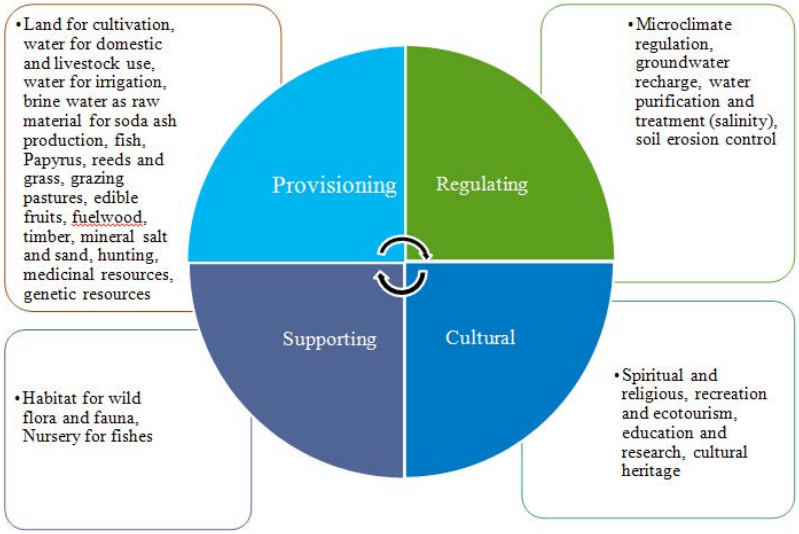

Figure 2: ESs identified in the study area (pre-1991).

Also, the villagers collected fruits, seeds, tubers, roots and leaves of different plants from the park's wetlands and used them as sources of food as well as traditional medicine. The wetlands provided households with reeds and grass for thatching and foraging. As pasture was abundant in the surrounding wetlands, there was no shortage of feed for their livestock.

As a supporting service, the wetlands provided habitat for wild flora and fauna, as well as a fish nursery (Figure 2). In the park, a total of 436 species of birds were recorded (of which 114 were wetland birds). A significant part of the park's history was the presence of wetland birds migrating from the Paleo-Arctic during the northern winter. The wetlands in the park served as a stopover for a wide variety of birds, including Lesser Flamingo *(Phoeniconaias minor)*, Greater Flamingo *(Phoenicopterus roseus)*, Northern Shoveler *(Spatula clypeata)*, Pied Avocet *(Recurvirostra avosetta)*, Eastern Yellow-billed Hornbill *(Tockus flavirostris)*, and Great White Pelican *(Pelecanus onocrotalus roseus)*, among others.

During the field, survey opinions were recorded regarding the cultural services of the park. As revealed by villagers, many visitors visit the park to admire the beautiful wonders of birds interacting with their natural environment. The number of bird-watching tourists visiting the park wetlands was high, and many of them stayed long in the area. Meanwhile, the revenue generated from the park was high. Some residents directly benefit from tourists by being tour guides and selling handicrafts, while others indirectly benefit through leisure and entertainment with tourists. Additionally, the park served as a hub for researchers and students from across the world [7].

Assessing ESs and their Changing Trends since 991

Interviewees were asked to identify and discuss the history of key ESs that existed prior to 1991 but are currently missing from the site. A total of five important ESs had disappeared from the wetlands. Fish, papyrus, water reeds, and hunting are among the PSs; the fifth is a cultural service, spirituality, or religious practices.

Fish that AW offered to local communities has now become unavailable. A sudden decline in the number of AW fish has been observed since FDRE came to power. Since 1993, as per Reaugh-Flower (2011), there have been no fishing activity in the AW.

The wetlands in the park were also overgrown with wetland vegetation. Discussants indicated that villagers harvested wetland vegetation such as papyrus *(Cyperus papyrus)*, water reeds like Typha *(Typha latifolia)*, Schoenoplectus *(Schoenoplectus corymboses)*, and other thatching materials to meet various local needs. Papyrus was one of the most important wetland vegetation types in the area. Among the most well-known uses of the papyrus plant in the area was the construction of the unique boat (locally known as "Jabala") for travel on the lacustrine wetland, the wetland of Abijata. The following benefits of papyrus vegetation were noted and acknowledged by female participants in focus groups:

"We made baskets, carpets and mats out of papyrus and sold them at the local market. The vegetation was also used as a primary source of home energy, livestock feed and building raw materials. We saved time by not having to search for fuel wood because vegetation was available. Tourists bought papyrus-made handicrafts, and many people relied on this income source. This vegetation has since vanished from the park's wetlands. "

Although the plant disappeared from the site by this time, it is still present in small quantities in the wetlands of Tana and Ziway.

There have been some hunting practices in the park's wetlands since 1973, despite the fact that hunting in the protected area was not permitted. The core reasons for hunting wildlife by the villagers were for meat, recreation, to remove predators that can be dangerous to humans, domestic animals, or crops. The villagers, for example, hunted animals like hippopotamuses *(Hippopotamus amphibious)* for teeth, meat, and skins. There is no hunting at the moment because the wild animals that lived in the AW and river forest have now moved to another location. A very few wild animals left in the park. Many animals, including hippopotamus, disappeared from the site.

Historically, at the current study site, local villagers were connected to natural resources for their spiritual purposes. The most common place was the wetlands in the park. Participants in focus groups said that the park's wetlands were formerly used for spiritual events, but are no longer used for such occasions.

Local Communities' Perceptions of the Most Important Services

Based on the FGD participants' feedback, the top 10 services were identified and ranked (Table 1). The wetlands for cultivation (AW) were ranked first. A riverine wetland (mainly the Bulbula river) was followed by a lacustrine wetland for grazing livestock. Six out of ten services were PSs, followed by two regulating services, and cultural and supporting services (one for each service). These services were ranked according to their use in the household and/or their ability to sell them on the market for financial returns. As well, the cultural ESs that households perceive and appreciate at the community level were also used to rank services.

All services, with the exception of land for cultivation and pasture

Table 1: The Top 10 Services with details about their Current Status (compared to the past 30 years) as Perceived by Local Communities.

Services	Ranking	Trends of change (increasing/decreasing/no change)	Source/s of the services
Land for cultivation	1st	Increasing	Abijata and riverine
Water for domestic and livestock use	2nd	Decreasing	Abijata and riverine
Grazing land	3rd	Increasing	Abijata
Salt and sand mining	4th	Decreasing	Abijata
Recreation and Tourism	5th	Decreasing	Abijata
Medical resources	6th	Decreasing	Abijata and riverine
Groundwater recharge	7th	Decreasing	Abijata and riverine
Habitat for aquatic birdlife	8th	Decreasing	Abijata and riverine
Microclimate regulation	9th	Decreasing	Abijata and riverine
Water for irrigation purpose	10th	Decreasing	Riverine
Source: FGDs (2020)			

land, are diminishing, as seen in Table 1. The following are ten services that the local community has deemed the most popular, accompanied by detailed information about their current status (compared to the past 30 years) [8].

Land for cultivation

One of the most important services highlighted by focus group participants was wetland for farming. Part of the AW has been converted into farmland. Those households living nearby the wetland have been practicing extensive agricultural systems (using little or no chemical fertilizer and high yield varieties) as a direction for enhancing crop production. Inorganic fertilizer is used rarely in the area due to the alkalinity of the soil. During the focus groups in Galef Qello and Shalla Billa Kebeles (the south and southeast parts of the wetland of Abijata), farmers revealed the following:

"A shrinking of AW is viewed by us as an opportunity rather than a threat. The farmers living in a nearby wetland have been gaining more farmland each year as the area of the wetland shrinks. This presents an opportunity for us. The wetland stopped supplying fish to us. Because of its highly alkaline contents, the water of the wetland is also unsuitable for drinking by humans and domestic animals. Unfortunately, the unstable rainfall and poor soil fertility, along with the high alkalinity of the moist soil, result in poor crop yields in the area."

As part of the discussion, participants also pointed out that intensive agriculture occurs along the riverine wetlands. A few households have been using the Bulbula river for irrigation during the summer. This practice is limited to Dest Abijata Kebele which is located at the inlet of the Bulbula River to AW. Along the lacustrine wetland, the main crops are maize *(Zea mays)*, followed by haricot bean *(Phaseolus vulgaris)* and sorghum *(Sorghum sp)*, whereas tomato *(Solanum lycopersicum)* and onion *(Allium cepa)* are among the main crops grown along the river Bulbula.

Water for Domestic and Livestock

Riverine Wetland

The Bulbula river, which originates from Lake Ziway, is the main source of fresh water for AW as well as for the local residents living within and outside the park. The river is the most accessible drinking water supply for the villagers of Desta Abijata and Adansho Boranota Kebeles. Livestock keepers in the area are also dependent directly on this river for their livestock water needs. The river may dry for some months. Villagers access water during the dry season (October to February) by digging holes in the river or drawing water from alternative sources (such as Lake Langano and the Hora Qallo River).

The Hora Qello river is salty and not as widely used as the Bulbula River. However, this river has been used for drinking (by livestock and wildlife), washing, and swimming. Local villagers have noted a substantial change in the volume of water discharged by the two rivers into AW.

Lacustrine wetland: Wetland of Abijata

Ayenew (2002) describes Ethiopia's AW as an alkaline wetland. As a result, water for irrigation and drinking cannot be extracted. Villagers use it for washing clothes because they think it has the property of detergent. Nevertheless, the water from AW is used as a raw material for the production of soda ash.

Over the past four decades, the size of the lake Abijata, including its resources, has drastically shrunk. Measurements from satellite images show that the overall lake cover has decreased from 198.4 km^2 in 1972 to 131.8 km^2 in 2015. This means that the lake lost 66.6 km^2 (33.59%) of its surface area between 1972 and 2015.

Lake Shalla is the most exceptionally deep soda lake in Africa, with a maximum depth of 266 m. It is neither suitable for irrigation nor for domestic use.

Grazing Land

Grazing livestock around wetlands is a common practice in the study area. The wetland of Abijata serves as an area where local and some nomadic pastoralist communities communally graze their animals. During the winter months, many cattle keepers migrate to the wetlands of the park (Abijata) to graze their herds (Figure 3).

Resource Extraction: sand and salt mining

AW's shores are rich in minerals, including sand for construction and salt (called "Boji" locally) for feeding livestock. Minerals are illegally extracted by some villagers in order to earn an income. Some villagers sustain their livelihoods by selling the minerals they extract.

Recreation and Tourism Services

According to FGD participants, the creation of employment opportunities for park tour guides and scouts is one benefit the park provides to the villagers. The interaction with tourists also allows villagers to improve their knowledge. Interactions between tourists and local villagers often lead to a greater interest in education and participation in local wage-earning activities. Wetland birds are declining, so fewer people are visiting the park to watch them.

Figure 3: Grazing area on shore of abijata (a) Relocation of livestock to the AW (b) (Site Photo by the Researcher, 2020).

Medical resources

Water sources like Shalla hot springs and the two lakes, as well as traditional medicinal plants grown in the park, bear medicinal value. The riverine forest is the main place where medicinal plants are collected by traditional healers and the elderly. The most useful traditional medicinal plants identified by FGDs, including healers, are *Ocimum urtitolum, Solanum incanum, Croton macrostachys, Euphorbia scoparia, Aloe spp, Kalanchoe spp, Balanties aegyptica, Achyrantes aspera, Cussonia holstii, Clerodendron myricoides, Asparagus spp, and Capparis micrantha*, among others. Local healers use these medicinal plants to treat various diseases like dog bites, tapeworm infections, tooth infections, and other acute and chronic diseases.

Wetland water has been and continues to be used as a local remedy. Locals believe that the water from the two lakes can cure fungal infections of the skin, and relieve itching and wounds. It can also eliminate dandruff and scalp diseases (*Tinea capitis*, or ringworm of the hair). As described by the interviewees, water from the lakes is also used to treat livestock inches and wounds.

Groundwater Recharge

As ASNP wetlands are hydrologically connected to other CRV lakes, rivers, and groundwater, they greatly contribute to groundwater recharge. Groundwater, in turn, is used for drinking and replenishing the flow of streams and reservoirs. The FGD participants noted, as well, that summer is a better time to access groundwater, whereas winter is more challenging. In light of this, the water refill service is well received by the residents [9].

Habitat for Aquatic Bird Life

The park was created with the primary purpose of protecting and conserving the many waterbirds that breed in Lake Shalla and feed in Abijata wetland. As per Worku (2019) report, the park was home to about 436 bird species, which makes up almost 52.5% of the country's bird population. There has been a decrease in the number of earlier bird species in recent years due to a lack of vegetation and fish in wetlands, which both wetland and terrestrial birds depend on for food.

Microclimate Regulation

Climate change could change wetlands forever, but in turn, healthy wetlands can also help to mitigate the impact of climate change via regulating, capturing, and storing greenhouse gases, or GHGs. Their dense wetland vegetation, algal activity, and soils can regulate processes such as decomposition, which generate GHGs. People in the area were aware of the benefits that vegetation in wetlands provided for maintaining local conditions, since shade trees were needed for themselves and their livestock.

Irrigation practice

There are a few members and non-members of the village who depend on the river Bulbula for small-scale irrigation prior to entering the AW.

The Drivers of Changes in ESs

There have been so many arguments and propositions put forward to explain the drivers that contribute to the current status of the park's wetlands and its ESs, in particular the lacustrine wetland of the park. The key drivers of change in wetland ESs over the last 30 years have been identified through analysis of household surveys and focus groups. Based on the household survey, we identified seven direct and three indirect drivers of ES changes (Figure 4). In the study, water abstraction (99%) was identified as the main threat, followed by population growth (89%) and deforestation (84%), as well as climate change (64%) and villagers' lack of involvement in conservation practices (61%). Each of these determinants of ESs change is discussed below.

Intensive Water Abstraction

Increased water abstraction from AW for soda ash production, as well as from its primary feeder river, the Bulbula, for irrigation and domestic use, has resulted in a rapid reduction in the wetland's water level.

Irrigation around Ziway Lake and its two tributaries, the Katar and Meki Rivers, has been extensive. As a result, the amount of water flowing into Lake Ziway, which is the river Bulbula's principal source, has decreased significantly. Apart from small-scale irrigation, the expansion of large-scale farming projects for horticulture, floriculture, and vegetation production along the banks of Lake Ziway and the Bulbula river consumes a lot of water and discharges chemical pollutants into the water. Various farming operations also drain water from the Bulbulaa river during the dry season, preventing water from flowing into the wetland. Similarly, Giweta & Worku (2018) stated that agriculture's modernisation and expansion of capital-intensive agriculture, such as greenhouse flower and fruit production, is driving

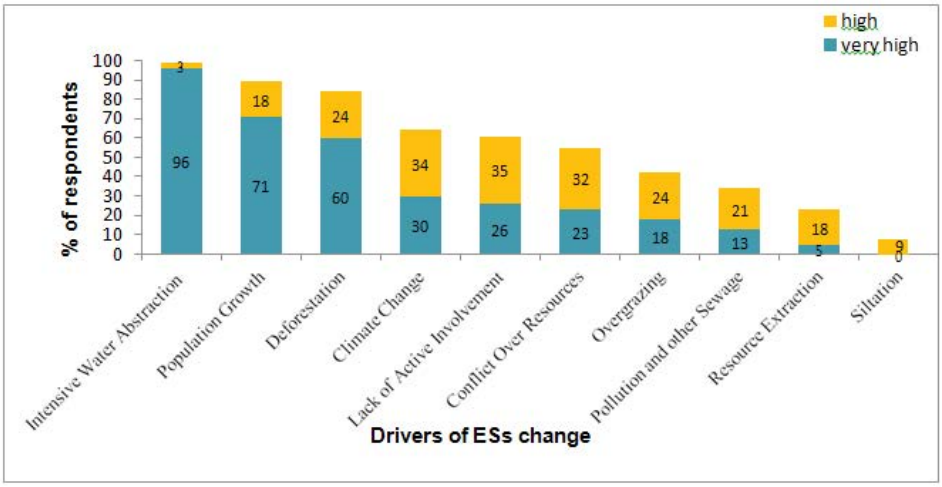

Figure 4: Drivers of the changes in ESs as determined by the household survey participants.

up irrigation water needs in the CRV region, putting a strain on the wetlands' water resources.

Bulbul River is also used for livestock and domestic purposes. As a result, the volume of its water is reduced, and less water is discharged into AW, causing the wetland's water level to plummet.

Another water user is the Abijata soda ash plant. The Ethiopian government founded the company in 1985 on the AW's shores to produce soda ash from Sodium Bicarbonate ($NaHCO_3$) dissolved in wetland water. After the wetland water is pumped into 17 specially built artificial evaporation ponds, sodium bicarbonate is left behind. When sodium bicarbonate is heated, it decomposes into Sodium Carbonate (commonly known as soda ash (Na_2CO_3)), water and Carbon dioxide. The company's claimed production capacity is 20,000 tons of soda ash per year, but its peak output in the year 2001 was around 7,500 tons. The company produces 4,500 tons of soda ash on average each year, using 150 m3 of water per ton.

The beach at AW has been shrinking for years since water discharged from the wetland into the ponds doesn't return. Because of the drop in AW's water level as well as the fact that the wetland's edge has migrated away from the pumping station (shrinking to the center), soda ash production is at its lowest point in history.

The company plans to produce 200,000 tons of soda ash per year, using 30,000,000 m^3 of water from Lake Shalla instead of Lake Abijata. The production of soda ash from Shalla Lake water is a future threat, given the company's production plan.

Since the company's inception, the depth, volume and size of the AW has declined along with its resources. Earlier studies by Jansen (2007) and Vilalta (2010) have confirmed this. The fish had vanished after eight years of the soda ash company's establishment. Declining wetland water levels, reduced tilapia breeding grounds, excessive salinity, and toxins and pesticides in the water that limit fish and/or algae growth, among other factors, were the most likely causes of fish disappearances, according to.

Population growth

Even though the protected area, as a conservation tool, is seen as one way to buffer ESs and biodiversity against threats, the ASNP existed largely as a "paper park," a protected area in name only.

The park has been home to indigenous local people who rely on the goods and services it provides. The human population in the park rose from 2,820 in 1971 to 55,000 in 2010, almost 20 times higher, and rose to 60,000 by 2020. Since 1971, not only has the human population in the park increased, but the livestock population has also increased, from 30,410 in 1971 to 202,644 in 2010, the number rose to 300,000 in 2020. As the number of people and livestock has increased simultaneously, local residents have been exploiting wetlands in order to sustain themselves and their livestock.

Deforestation

Deforestation is another key contributor to the current state of the park's wetlands. Although legally prohibited, acacia trees and other riverside trees have been harvested by villagers for firewood, charcoal and house construction. This is in line with previous research by Kefyalew (2008) and Reaugh-Flower (2011), which found that the vegetation cover has already been deteriorating due to charcoal production and farming. Illegal logging is a major threat to the park in this respect.

Climate change

Wetlands are important because of their ability to absorb and store greenhouse gases and provide services that can assist individuals in adapting to climate risks (Mitsch & Gosselink, 2015).

Despite being part of the solution to climate change, wetlands are one of the ecosystems most affected by even slight changes in the climate and the resulting changes in hydrological patterns (Mitsch & Gosselink, 2015). Higher temperatures, for example, can increase evaporation from soil and wetland surfaces and transpiration from vegetation. The situation is especially serious in shallow wetlands with low surface area to volume ratios, like the wetland of Abijata. Declining precipitation also affects the amount of water available and the vegetation that protects wetlands. As evidenced by Ayenew (2002), climatic change and variability, in particular the drastic reduction of precipitation in the sub-basin since the 1960s, have adversely affected the AW. For instance, Lake Chad, was once the sixth largest lake in the world, but due to drought since the 1960s, its size has been reduced to 1/10 of its original size (Onuoha, 2009). Climate change, in addition to human activities, has contributed to the shrinkage of the AW along its ESs and feeder rivers.

Lack of active involvement of local communities in conservation practices

The designation of protected areas alone does not ensure the protection of natural ecosystems within their boundaries (World Bank, 2010). The participation of wetland users in wetland conservation and management is crucial for extenuating the problems related to wetland ecosystems. Local users are the sole owners as well as the protectors of their resources (Shrestha, 2011).

The local communities at the present study site depend on wetland resources for their subsistence and economic well-being without participating in their conservation or management. The feedback of the FGD participants revealed that locals aren't involved in conservation activities. Also, a portion of the park's revenue does not go to the expansion of the park's capacity or to improving the livelihood of the surrounding population. There is a perception among most villagers that the park belongs to the government. In turn, communities in the area are less willing to embrace and contribute to conservation efforts. Furthermore, participants stated that the absence of a clear demarcation between wetlands and other types of land use. This allows villagers to overexploit ecosystem resources and convert wetlands as they see fit.

Conflict over resources

Villagers living in and around the ASNP have economic interests that conflict with the park's objectives. Local villagers were asked in the household survey what they liked about the future of the park, and the results are shown in the Table 2 below.

The majority of respondents (about 97.6%) prefer to own farmland,

Table 2: Local villagers' preference for the park area.

Future preference of the area ofASNP	No. of respondents	Percent
Well protected Park	8	2.4
Farmland	265	78.1
Communal Grazing land	6	1.8
Farm and Grazing Land	60	17.7
Total	339	100
Source: Survey Data (2020)		

Table 3: Are you happy with the existence of the protected area?

Are you happy with the existence of the park?		No. of respondents	Percent
	No	329	97.1
	Yes	10	2.9
	Total	339	100.0
Source: Survey Data (2020)			

grazing land, or both, rather than protect the area. The Ethiopian Wildlife Conservation Authority (EWCA) needs to safeguard the park by prohibiting people from residing there and taking advantage of its resources. Local villagers, on the other hand, prefer to use the area for settlement houses, farming, and pastures without retaliation, resulting in a conflict between the villagers and the park management. Residents were asked whether or not they were happy with the existence of the protected area. Majorities of residents are disappointed by the Park's existence. Table 3: Are you happy with the existence of the protected area?

As seen in Table 3, the majority of households (about 97%) were unhappy with the park's existence. As per Teferra & Fekadu (2014), the local people's claims to the park's land and resources, and the state's refusal to meet these claims, resulted in a long-running conflict.

The FGD participants commented on the locals' relationship with the park, claiming, "Our forefathers and mothers were born and lived here, and so were we. We did not come to the park; the park came to us. Villagers' desires weren't considered when the park was established. As a legal basis, we require a land certificate, but the government is unable to give this. We don't have any other assets to pass on to future generations. Our sole asset is our land. This has been a source of contention between villagers and the administration for many years. The government is doing nothing to answer our question."

Because of the uncertainty concerning property rights and a lack of ownership, park resources have been used in an unsustainable manner. As per Shimelles (2009), households who don't have secure property ownership can't invest in land management or properly use agricultural inputs. Farmers' access to credit, which is necessary to enhance crop production, is similarly limited.

Overgrazing

As wetlands are abundant with moisture and water, many crop producers and livestock keepers have shifted their focus to wetlands where they can cultivate crops and graze their animals. As soil and vegetation become disturbed, wetlands rapidly lose their wetland properties.

Pollution and other Sewage

Along the shores of Lake Ziway and Bulbula River, several greenhouse flower companies have been established. These companies have adopted the practice of prolonging growing seasons through irrigation. The practices often involved the introduction of excess fertilizers, chemicals, and frequent tillage.

The Bulbula River accumulates pollutants from adjacent areas through the intentional or unintentional discharge of wastewater and farm inputs. These forced their way to AW via the Bulbul river. These have an influence not only on the wetland's ecological traits and fauna and flora, but also on the quality of the river's drinking water. Likewise, Jansen (2007) point out that increased contamination levels in AW lead to fish extinction.

Resource Extraction: Sand and Salt Mining

Due to a lack of alternative economic options, some locals in the study area adopted maladaptive strategies. They utilize the AW's shoreline for sand and salt mining in order to subsist and bring in revenue. The wetland shoreline has been deteriorating as a result of this intervention.

Lastly, siltation was highlighted as a driver in the household survey. Siltation from tributary rivers, particularly the Bulbula River, prevents water from entering the lake, despite most of it being deposited at the base of upstream lakes (Ziway and Langano).

Conclusion

Before 1991, the park's wetlands, particularly the AW, supplied substantial ESs, including fish, to local villagers who lived in and near the park. Local villagers had access to thatching materials and traditional medicine from the wetlands. Some riverine forest and wetland areas were used as a source of traditional medicine, and water reeds like *Typha* and *Schoenoplectus* were commonly used to thatch roofs. Their livestock had plenty of pasture around the wetlands, so they did not run out of feed.

Some ESs, including fish, papyrus, water reeds, hunting, and spiritual practices, existed before 1991, but are currently missing from the site. Although some ESs have been lost, the park's wetlands continue to supply a variety of goods and services. Eleven of the 20 ESs provided by wetlands are PSs, followed by four regulating, three cultural, and two support services. The use of wetlands for cultivation ranked highest, followed by domestic water supply and pasture. All services, apart from arable land and pasture, have a declining trend in the study area. The ecosystems of the park are deteriorating to an alarming extent, and as a result, not only is it losing its tourist appeal, but also its status as a Ramsar site will be waning.

There are many factors contributing to the current condition of the wetlands. In addition to anthropogenic factors like water abstraction, population growth, and deforestation, there are also natural factors like climate change. One cause of Lake Abijata's depletion is the Abijata Soda Ash Company. In the sub-basin, anthropogenic drivers have exposed the park's wetlands to the harsh impacts of climate change. Climate change, on the other hand, has exacerbated the wetlands' deterioration by weakening their natural resilience.

Despite the villagers' perception that the aforementioned factors are most explicitly responsible for the degradation of the wetlands, notably the AW and its services, the absence of a wetland policy and an accountable institution in the country has also contributed to the park's wetlands' constantly changing.

Designation of protected areas alone does not guarantee protection of the natural ecosystems within their boundaries. Initiating community-based participatory wetland management practices like those of forest management practices, which are being practiced in certain areas of the country and are showing success, can be a role model. This can be achieved through Indigenous mutual-aid associations, such as "Idir" that will allow for sustainable management of this naturally occurring resource.

The CRV Wetlands Replenishment Project/Program, which primarily focuses on ecological restoration of Abijata-Shalla Park wetlands with the objectives of rehabilitating the wetlands and their ESs and biodiversity, and safeguarding them for present and future generations, should start as soon as possible as it assists the recovery

of an ecosystem and its ESs. Identify, ratify, and use international agreements to support these objectives (e.g., the RC). A wetland policy that guides the use of ESs in the country is also urgently needed.

Restrict any increase in water withdrawal in the Ziway-Shalla sub-basin, as this will have a negative impact on the water level of AW due to their hydrological connection. Instead, focus on water conservation strategies (e.g., closed-irrigation systems, drip irrigation, capturing and storing rainwater, watering at night to slow down evaporation, growing drought-tolerant crops, conservation tillage, rotational grazing, and farm systems) to make better use of abstracted water. To that end, integrated sub- basin-wide water resource management, with the participation of all stakeholders, should be the cornerstone of safeguarding the park's wetlands.

To trade-off destructive socioeconomic activities within the park, initiating conservation-livelihood enhancement tools like Payments for ESs (PES) schemes as an alternative for wetland ESs conservation through incentive mechanisms to local communities is essential. This will help to achieve a win-win strategy to satisfy both human welfare and ESs protection within the park.

The Soda Ash Company plans to use Lake Shalla because Lake Abijata's water level has reached a point where pumping is no longer practicable. This will damage nature's gift to humanity. We should stop repeating the tragic mistake of AW.

Statements and Declarations

Author Contributions

All the authors made substantial contributions to the conception and design of the study. Denbel Bedo performed tool development, data collection, data analysis, and wrote the draft paper. Abate Mekuriaw and Amare Bantider guided the research and reviewed the manuscript. All authors have read and agreed to the published version of the manuscript.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

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