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Feedbacks and Trade-Offs in the Use of Wetland Ecosystem Services by Local Communities in Rural Zimbabwe

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Abstract: Rural wetlands, especially in developing countries, have been exploited for different ecosystem services because they are considered safety nets for food production and are important for livelihood strategies and human wellbeing. However, there are gaps in knowledge of the ecosystem services provided by small, valley bottom wetlands, especially in dryland areas and how these services are used and managed by local communities. This study focuses on the ecosystem services of valley bottom wetlands in Zindi, the Honde Valley, in rural eastern Zimbabwe. Ethnographic observations of wetland users' activities and individual interviews with local residents and village heads were undertaken in this study, focusing on how people make use of the different ecosystem services that are derived from these wetlands. Results show that the wetlands are mainly utilised for provisioning services, but that these are related to the availability and properties of supporting and regulatory services in the wetland environment. All of these services are also strongly mediated by the traditional cultural contexts and values held by local communities. The results show that the exploitation of some ecosystem services leads to negative impacts on the availability or properties of others, and this means that there are trade-offs in the uses and management by individuals and communities as a whole. These feedbacks and trade-offs are not well explored in most studies but are critical in considering community responses to changing wetland resources, in particular under climate change. This study recommends that policymakers should include small and often hitherto overlooked wetlands in their management plans, since they are critical for supporting rural livelihoods. It is also important that wetland management plans aim to improve the range and sustainability of ecosystem services available and avoid the need for unnecessary trade-offs in their use by local communities.

Keywords: wetland resources; ecosystem services; indigenous communities; valley bottom wetlands; ethnography; food security

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1. Introduction

Globally, wetlands have been exploited for the different ecosystem services they provide, both direct and indirect, that contribute to human wellbeing [1–5]. Local communities are therefore connected to wetlands since their ecosystems services contribute to human livelihoods, especially in areas that are water-scarce [6–10]. According to the Millenium Ecosystem Assessment [11], the ecosystem services provided by wetlands are provisioning (food, fresh water, fibre, and fuel), regulatory (water purification, water regulation, and climate regulation), cultural (spiritual, recreational, aesthetic, and educational), and supporting services (soil formation and nutrient cycling). However, in practice, these service types are closely interconnected [12,13], and there is therefore a need to explore these relationships in more detail in order to understand how any one service or resource may influence other services. Previous research has emphasised the ecosystem services provided by large wetlands, but this tends to overlook small or remote wetlands despite these being pivotal in providing ecosystem services to sustain rural livelihoods, especially

in the developing world [14]. In Africa, seasonally flooded wetlands such as dambos or vleis have been used to support agricultural systems, with local people using the wetlands for food, water, firewood, and fibre resources [15–19]. In Zimbabwe, the capacity of dambos to allow for multiple cropping and to retain moisture for long periods has resulted in their widespread use for cultivation [20,21]. Wetlands therefore play a vital role in reducing poverty through their provisioning services of food production, in particular [6,11,15,22,23]. Increased rural populations and changes in socioeconomic practices have increased the demand for provisioning services [11,24,25] especially related to the commercialisation of wetland agriculture. However, not all wetlands provide all ecosystem services equally [26], according to their physical properties of soil and water, their size, and different ecosystems [27,28]. Broadly, the ecological status and characteristics of wetlands determine the nature and types of ecosystem services available. The overexploitation of wetlands also determines the nature of trade-offs between different ecosystem services [29–31]. As a result of different anthropogenic activities, ecosystem services in wetlands do not remain static and are not either equally available or equally depleted [31].

These issues are explored in this study through the use by local communities of valley bottom wetlands in rural eastern Zimbabwe (Figure 1). Zimbabwe has a variety of small wetlands, locally termed dambos or vleis, and these occupy 3.6% of the country's total land area [32]. These seasonally waterlogged wetlands are found in footslope locations at the bases of dry upland areas [33–35]. The presence of seasonally-wet valley bottom wetlands in semiarid countries such as Zimbabwe should therefore be acknowledged as key providers of ecosystem services that contribute to human wellbeing. This study selected six wetlands (Tawarara A, Tawarara B, Rutsate, Mareya, Chiwira, and Madimbo) as case studies from the Honde Valley area of eastern Zimbabwe. This area was purposively selected due to the severity of wetland exploitation and because there are no previous studies on this topic in this area. The objectives of this paper are to (1) identify the different ecosystem services provided by the valley bottom wetlands and assess the relationships between these ecosystem services, based on observations of and interviews with local community members; (2) assess how the different ecosystem services provided by these wetlands have contributed to human wellbeing; and (3) consider how the trade-offs in the use of specific resources and ecosystem services frame the ways in which these wetlands are valued and managed by local communities.

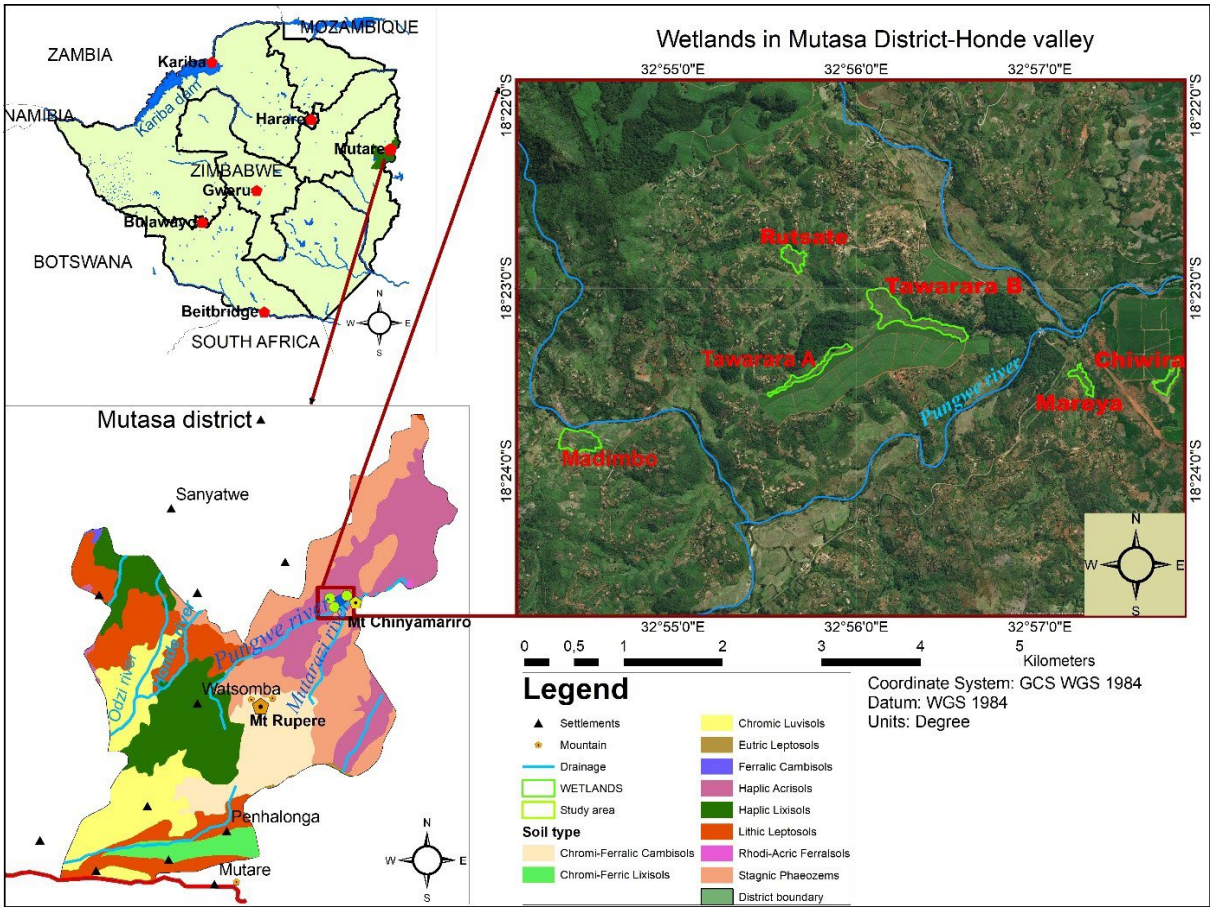

Figure 1. Map showing the studied wetlands in the Honde Valley, Zimbabwe.

2. Materials and Methods

2.1. Study Area

Six wetlands were examined in this study in Zindi, the Honde Valley, in eastern Zimbabwe (Figure 1). These small wetlands are intensively exploited by local communities for their ecosystem services, mainly for agriculture, and range in size from 2.4 hectares to 13.6 hectares. The Honde Valley is located in the Mutasa District (18°29′ S, 32°50′ E; elevation 912 m asl) within the Zimbabwe Eastern Highlands. The Honde Valley area is part of the Odzi-Mutare-Manica Greenstone Belt, which is made up of Archaean granites [36] and has orthoferralitic soils with high organic and clay contents and, thus, generally high soil fertility [37]. This region has a subtropical to temperate climate with mean annual temperatures of 15–18 °C and total annual rainfall in the range of 900–1000 mm [38]. Most rainfall falls in summer and is related to the movement of the Intertropical Convergence Zone [39]. The main rivers in the Honde Valley are the Pungwe and Honde, and these and many smaller streams are associated with wetlands, especially in footslope locations. The soils and climate of the region support plants of the Afromontane phytogeographic region, with a high degree of endemism [40] and also support smallholder and subsistence farming communities.

The study area has an agrarian economy with rural dwellers mainly practicing subsistence and semi-commercial to commercial agriculture [41]. Rural dwellers keep a variety of livestock (cattle, goats, and sheep) and grow crops such as potatoes, maize, coffee, tea, yam, groundnuts, and sugarcane. Fruits such as apples, bananas, and pineapples are produced in this area because of the cool climate [42]. Market gardening is also practiced, and people grow different types of vegetables for consumption. Bananas, pineapples, and apples are grown mostly for sale. Smallholder farmers in Honde Valley also grow yams on wetlands

and near riverbanks for sale and consumption. However, due to the short rainy season and unpredictable rainfall, many wetlands in the Honde Valley are drying up, and the area available for growing yams is decreasing [41]. Bananas are also a source of income, as smallholder farmers can grow them through irrigation in some wetlands [42], and bananas are sent for sale in cities such as Mutare, Harare, and Bulawayo as well as local towns such as Rusape and Chivhu [41].

2.2. Methods of Participant Data Collection and Analysis

Qualitative methods such as direct observation, and semi-structured interviews were used to for in-depth understanding of the ecosystem services provided by valley bottom wetlands. Residents of local farming communities around the six wetlands were sampled, since they interact with the wetlands daily through farming activities and so have knowledge of the different ecosystem services they derive from the wetlands. Snowball sampling was used to select participants for interviews with the final sample size (n = 49) determined by data saturation. The interview schedule comprised 40 questions divided into two sections. Section A dealt with respondents' demographic and background information such as age, employment status, education, size of family, any farming activities they practiced, and whether they were using wetlands and in what ways. Section B had open-ended questions on the types of crops grown, methods used for crop production, any changes observed in wetland water, soil, plants and animals, wetland users' interaction with different stakeholders, and conflicts related to wetland land use. Interviews were undertaken in the local language of Shona and audio recorded with permission of the participants.

Interviews were also conducted with village heads (n = 3), as they are traditional community leaders who have influence on wetland access and use and act as liaison points with government officials and extension workers. The village head interview questions focused on how wetlands were used in the past and present, any traditional beliefs on wetland use, whether they impose regulations on the use of wetlands, and any challenges they face in enforcing these regulations. Direct observations and photographs of wetland users and their activities in the wetlands (in farming, harvesting, tending crops, collecting water, and plant products) were also undertaken with permission in order to establish how users interact with wetland resources of different types and, through informal conversations, to explore their motives, values and decision-making processes. Transcribed semi-structured interviews were analysed through a qualitative content analysis by a process of coding and categorisation, followed by thematic analysis. Relevant textual data were then coded inductively, and themes were developed through data interpretation. This study received institutional ethics approval, number H18/09/13. Results are reported herein in an aggregated form from across the six wetlands.

3. Results

3.1. Extraction of Food Resources from the Wetlands

The six valley bottom wetlands in Honde Valley were exploited mainly for their provisioning services for food production. Most respondents (92%) had farms or were making use of ecological resources from the wetlands. Farmed crops included tea, pineapples, maize, yam, sugarcane, groundnuts, cassava, and beans; leafy vegetables such as cabbage and kale; fruit and vegetables such as okra, eggplant, tomatoes, and peppers; tuber vegetables such as potatoes, ginger, and turmeric; and bulb vegetables such as onions and shallots. Exotic fruit trees such as bananas, mangos, avocados, lemons, oranges, litchis, and naartjies (tangerines) were also grown, mainly for sale. The key reason stated for the agricultural use of wetlands was the favourable conditions for plant growth related to water and nutrients (90% of respondents), allowing for food security and income generation. In addition, most (80%) respondents were engaged in livestock-keeping on the wetlands with chickens, goats, pigs, and cattle recorded. Of all the respondents, 18% were involved in crop production only, 2% in livestock only, and 78% in both. Two farmers were engaged in fish farming for consumption and sale, one of which said that she would harvest about 100 kg of fish during

six months for sale both locally and to nearby towns. Only one respondent (2%) was not engaged in farming activities. These different agriculture types have different requirements in terms of resource use, foraging, water, and these requirements also vary through the year. Most respondents (90%) concurred that early harvest from wetland crops cushioned them against late and unreliable harvests on surrounding drylands. Although bananas and sugarcane were grown for sale, they were also recognised by farmers as useful in reducing soil erosion (bananas) and for decreasing soil moisture in waterlogged areas (sugarcane).

Besides harvesting a variety of crops and fish from formal agriculture, respondents also collected fruits from both indigenous and exotic trees. Indigenous fruits include maonde (from muonde or fig trees), hute (from mukute or *Syzygium cordatum* trees), and magopokopo (*Mystroxylon aethiopicum* trees). Indigenous plant vegetables and also mushrooms were harvested from wetlands during the rainy season (Figure 2). These plants include those locally known as derere (*Corchorus olitorius*), teketere (*Galinsoga parviflora*), nhungunira (*Bidens pilosa*), tapa (*Justicia* spp.), mutsematsema (*Cleome monophylla*), mutsungura (*Solanum nigrum*), and mubvunzandadya (*Chenopodium album*). Some farmers kept bees in the wetlands, with honey for consumption or sale. Bee farming was common in the Madimbo wetland, where farmers kept their beehives in and around the river adjacent to the wetland. Respondent 19 explained that they preferred placing the beehives on trees in and around the wetland rivers because they believed that flowers in these wetland trees attracted the bees (Figure 2). Besides formal agriculture, mice and locusts were also caught in the wetlands for food, in particular by children and when the wetlands were left idle from April to the end of July (dry season) and where the growth of grass and weeds provided shelter for these animals and insects.

Figure 2. Exploitation of food resources from Honde Valley wetlands. (**a**) A farmer picking mushrooms; (**b**) indigenous fruit collection; (**c**,**d**) beehives placed on trees round a river; (**c**) a beehive made by the owner of the beekeeping project; (**d**) a beehive made by a carpenter.

3.2. Farming Methods Used by Farmers

Respondents used different farming methods and practices in the wetlands, informed by their socioeconomic background, technical expertise, access to machinery/chemicals, and the cultural context of traditional practices. All (100%) the farmers used organic manure and hand-dug trenches by ploughing. A majority also dug holes for planting purposes (57%) and used crop residue, grass, and manure as mulches (75%) or other inorganic or organic fertilizers (65%), the latter also including tea leaves and leaf litter. A minority of farmers (26%) used zero tillage. Woody and leaf debris was composted at the start of the dry season in March before applying to the fields in August when many crops were sown. The role of traditional and indigenous knowledge in agricultural practices is shown by the example of yam production, discussed by many respondents in the field. Respondent 6 reported that farmers used organic manure for yams to ensure that the yam bulb develops, and that artificial fertilisers make yams rot if they receive too much rainfall. Most yam producers dug holes for planting, whereas respondent 5 reported that digging holes was an old system and that he preferred to use ridges, which he said gave the yam and cocoyam bulb more room to grow (Figure 3). Respondent 20 said:

Figure 3. Methods of planting yams in the study area. Farmers (**a**) digging holes; and (**b**) digging ridges.

> *"When I got married here, we used to dig holes, but now we are digging ridges. I am the one who started the ridge system here on Madimbo wetland, and people started copying. I decided to use the ridge system because it makes it easy to bury the yam into the soil when planting it. When using ridges, you have to go inside the ridge and start putting the soil on top of the yam from both sides. It is also easy to mound soil around the yam when using the ridge system. When the yam is planted using the ridge system, it also has more room to grow big. I thought of this ridge method after spending a lot of money contracting people who would help me mound soil on the yam."*

However, respondent 16 said that she was unwilling to change to the ridge system since she once tried it and it was difficult for her to mound soil around the yam and cocoyam. Ridges also allowed farmers to make use of the limited space available to them to plant crops; hence, this allowed them to practice intercropping and mixed farming. Thus, after planting yams, maize was planted on top of the yam ridge two weeks later because yams take longer to germinate than maize. Respondent 20 also added that ridges allow for a higher plant density than holes and, therefore, use the land more efficiently.

Trenches have been hand-dug by ploughing on all wetlands. Trenches drained both the surface and underground water and often marked the boundaries of each farm. Trenches were normally connected together or directed into one big trench, and this could sometimes develop into a small flowing stream. Farmers left grass adjacent to the trenches and sometimes planted sugarcane at the edges of trenches in order to hold the soil together.

Respondent 13 said that people were supposed to avoid digging trenches, since this would lower the water table. Respondent 9 noted that trenches were supposed to be closed at both ends so that the water would drain underground and not overflow and cause erosion, as was observed in the Rutsate wetland. Flooded trenches compelled farmers to build access bridges to the wetlands, and this involved clearing vegetation and cutting down trees to make wooden log bridges.

3.3. Other Goods and Services Found in Wetlands

Besides for food and agriculture, wetland water was used for domestic purposes such as cooking, washing, bathing, and drinking. Water was collected from wetland spring wells using plastic containers. Some respondents would also bath and wash their clothes in the wetlands (Figure 4a), but detergents could potentially affect aquatic plants and insects. Both natural and planted bamboo were harvested for making handicraft items such as baskets, lamp holders, handbags, and toiletry holders (Figure 4b). Medicinal plants were also harvested from the wetlands, and these were used to treat different disorders (Table 1). Their use was informed by indigenous and traditional knowledge. Respondents 1 and 11 noted that some medicinal plants are removed when farmers prepare the soil for crop planting. Respondents 2 and 3 also said that the use, and even knowledge of, medicinal plants conflicted with their Christian beliefs, highlighting the multiple cultural contexts in which wetland resources were viewed and used. Respondent 3 also noted that there were fewer traditional healers who have insight into which medicinal plants were useful, or who could teach others about these, and thus such traditional knowledge was being lost.

Table 1. Examples of medicinal plants found in the wetlands and their uses by local people.

Botanical Name	Plant Species Local Name	Type of Illness to Be Treated
Ximenia caffra	Bawa	Backache
Breonadia salicina (*Adina microcephala*)	Muonya	Backache
Grewia bicolor	Mungurawe	Stomachache
Erythrina abyssinica	Mutiti	Diarrhoea
Syzygium cordatum	Muhute	Coughing
Scleria foliosa	Jekacheka	Menstrual cramps
Carissa bispinosa	Kayanyasika	Backache
Zingiber officinale Roscoe	Tsangamidzi	Stomachache

3.4. Cultural Use of Wetlands

Cultural services founded on indigenous knowledge were also provided by these wetlands, and in different ways. Village head 1 said,

> *"We are still burying children in the wetlands, especially those who die soon after birth and stillbirth. We bury these children in wet places such as wetlands."*

This traditional practice, however, was not always continuing today, but wetlands were still valued as sacred places that have cultural resonance. Village head 1 said,

> *"Some places are still sacred though there are few. There are also sacred wells that do not dry up. All metal things are not allowed to be brought close to these wells to fetch water from these sacred wells except clay pots."*

Respondent 6 explained that

> *"Our well called Ben's well dried up once another year because we had taken some dirty pots from the fire and soap there. We had to spend almost a year fetching water from a well further away until our elders performed some rituals, then the spring water came out of Ben's well."*

Traditional leaders considered it taboo for older people to clean around these sacred wells, and young mothers and girls were sent to remove dirty items from around the wells. The village heads did not allow people to visit the wetlands at night or dressed in tattered clothes or half-naked. However, most of the spring wells that used to be sacred were no longer considered as such because people had stopped following traditional practices and values. Village head 3 said:

> *"It used to be a traditional practice that village members would come and help the village head weed his wetland fields to honour him. But now people are not doing that. People are now practicing modern ways of living which do not respect our traditional practices. So if I call people for such gatherings, few people come. Most people no longer understand our culture and practices."*

Likewise, brewing beer before the onset of the crop planting season was a common practice in the area. Village head 1 explained that beer would be brewed at the chief's home, and the chief would then announce the beginning of the planting season after performing traditional rituals. However, some farmers were too impatient and start to plant their crops before the ceremony. These traditional practices were also eroded by Christian beliefs.

Figure 4. (**a**) Bathing area on a stream in Tawarara A wetland. Wetland users use the rocks as a clean and safe platform to stand to bathe. They avoid making the water dirty by standing on the rock whilst bathing. The big stones created clean area for them to put their toiletries. (**b**) Handicraft items made from bamboo harvested in the wetlands.

4. Discussion

4.1. Different Ecosystem Services Provided by Valley Bottom Wetlands

Wetland use is discussed using the ecosystems services approach as a way of assessing the relationships between different ecosystems and their contribution to human wellbeing and decision making by wetland users [43–45]. The results show that wetland ecosystem services are highly diverse and are exploited in different ways by wetland users according to their needs and values and informed by their community cultural contexts. Figure 5 illustrates the interconnections between different service types, as based on evidence from the interviews and observations with Honde Valley wetland users. Supporting services such as soil formation through the accumulation of organic matter and nutrient cycling provide the framework for provisioning, regulatory, and cultural services (Figure 5). Different provisioning services include indigenous and exotic fruits, traditional vegetables, medicinal plants, food crops, fish, and honey (Figure 2). However, these can only develop because of the physical environmental resources providing supporting services in the wetlands [46]. These patterns are also found in other Zimbabwe wetlands [47–49].

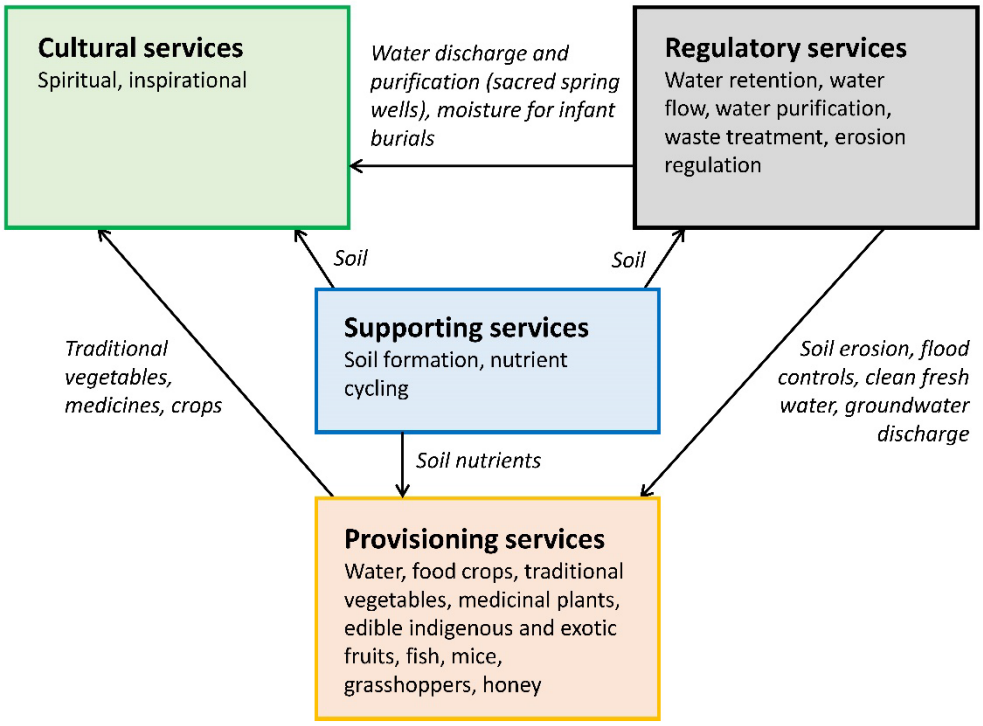

Figure 5. Relationships between different ecosystem services found in Honde Valley wetlands.

Provisioning services also include natural food products that are secondary outcomes of wetland plant systems and biodiversity. Different plant species grow when the wetlands are left idle after crop harvest, and this provides habitats for grasshoppers and mice that are then hunted. The availability of fish, grasshoppers, mice, traditional vegetables, and wild fruits shows that local residents make use of diverse nutritional food sources. Fish is considered a delicacy in these rural areas, and therefore fish farming for consumption and sale is seen as an important economic activity. This is similar to the Bahi wetland in Tanzania, where local communities rely on wild fish for protein and sale [6]. These wetlands therefore act as socioeconomic safety nets for food security, as they provided diversified diets with various nutrition-rich food that could be easily accessed for little or no cost, and during the dry season.

The unique geographical location of these valley bottom wetlands allows the accumulation of organic matter from upslope, making them more fertile and productive than dryland rain-fed agriculture. As the main activity that significantly contributes to food security, agriculture is successfully carried out due to the availability of supporting services that ensure the availability of nutrients for crop growth (Figure 5). Wetlands in semiarid areas have long been used intensively for agriculture due to their higher water availability and productive soils [47,49–51]. Thus, the availability of water and good soil also ensures the availability of provisioning services (Figure 5). Climate variability, which results in erratic rainfall patterns and unproductive dryland soils, compels farmers to turn to wetlands for agriculture. This concurs with findings that show an increase in wetland cultivation on rural wetlands in Midlands Province, Zimbabwe, due to a decline in rainfall [48]. Climate variability had therefore increased pressure on the wetlands. Most of the respondents (90%) in the Honde Valley wetlands are subsistence farmers who depend on selling surplus yields for income, showing that the wetlands act as economic hubs for the community. This is similar to other studies in rural wetlands in Zimbabwe and elsewhere [49].

Although only a few farmers did fish farming and basket weaving, these are considered critical economic activities significant to rural livelihoods, since a high income can be generated [47]. The growth of bamboo and reeds in Zindi wetlands was due to supporting services such as hydric soils and a downslope supply of nutrients that help plant growth.

A similar study in the Midlands province indicated that rural people were using wetlands to grow various crops, which attracted external markets [48]. Other work also suggests that, despite relying on food imports, the basic needs for food consumption in urban areas in Africa more generally are supplied by rural farmers [52], similar to the internal trade networks into which wetland users in the Honde Valley are connected, to urban centres in Harare and Mutare. However, increased crop diversity in the Honde Valley was not only crucial for external consumers but also for the economic and food security of local people. Exotic fruits such as bananas and avocadoes were grown in the wetlands, and indigenous fruits helped supplement the community's diet.

Water as a crucial wetland resource is exploited and managed in both direct and indirect ways. Spring wells providing clean and fresh water are found in all the wetlands. Regulatory services through hydrological flows allow groundwater interactions through springs and water purification through the absorption of pollutants and by flood regulation along drainage trenches and streams [7,24,53]. Here, local people take water from the wetlands for household use and by created bathing places (Figure 4a). It is difficult to drill boreholes in upland areas surrounding the Honde Valley because of the terrain, making the water table too unreachable. This, therefore, focuses community water use on valley bottom wetlands. Although the hydrological flows and processes were significant for provisioning services of clean water, they are continually disturbed by the exploitation of wetlands for agriculture. This has the outcome that regulatory services are decreasing, which is evidenced by the drying up of some parts of the wetlands and the presence of soil erosion. The similar deterioration of wetland systems is noted elsewhere [25,27,44]. The supporting services of wetland soils help maintain the regulatory services of soil retention, soil erosion, and flood buffering (Figure 5). Agriculture also significantly transforms wetland environments despite the presence of natural ecosystems [54]. This means that human activities such as agriculture can impact both supporting and regulatory services, which increase the vulnerability of the wetland to climate change, and other processes such as urban encroachment and wetland drainage [55,56].

Figure 5 shows some of the linked relationships between different ecosystems found in the Honde Valley wetlands. Supporting ecosystem services provide the framework that leads to the development, properties, and dynamics of provisioning, regulatory, and cultural services. Supporting services such as soil and sediment retention make it possible for wetlands to provide regulatory services such as the regulation of hydrological flows, water purification, and waste treatment. Simultaneously, regulatory services such as hydrological flows through groundwater discharge and water purification help ensure the availability of cultural services such as sacred spring wells or the availability of medicinal plants.

The wetlands examined in this study are also valued for their cultural services, which suggests that these services provide local communities with a sense of identity, cohesion, place, and relationship to past generations. Key foodstuffs obtained from wetlands such as yam and cocoyam, which were grown in the past, link residents to their traditional cultures, diets, and activities/rituals [50,57]. This also includes harvesting medicinal plants (Table 1). Traditional practices such as infant burial imply that wetlands can still provide sites and practices of traditional religious or cultural significance. Such cultural ecosystem services also play a role in enhancing people's social wellbeing [58,59], and these can be attained through supporting services and partly by regulatory and provisioning services (Figure 5).

4.2. Impacts of Wetland Agriculture on Different Ecosystem Services

The different types of agriculture and different crops grown on the wetlands impact on natural ecology and biodiversity. Although sustainable agricultural practices are essential for bringing about socioeconomic and environmental benefits [60], wetland farmers in the Honde Valley employ both 'sustainable' (mulching, use of organic manure, zero tillage, and mixed intercropping) and 'unsustainable' practices (deep ploughing, burning of weeds, streambank cultivation, digging of trenches, and use of inorganic fertilisers) in their agriculture. Since this community relies on wetland farming for food as well as other

socioeconomic benefits, these different farming practices are used for their instrumental value in providing such benefits. Sustainable farming methods such as zero tillage ensure a minimum disturbance of wetland soil by preserving soil fertility and reducing soil erosion and compaction. Zero tillage also reduces production costs, as it allows tillage savings. However, few farmers (26%) were using zero tillage, whilst most farmers preferred hand-dug ploughing (74%) during land preparation to destroy weeds and grass. A similar study on dambo cultivation in Chiota, Zimbabwe, also showed that zero tillage and digging are the most common farming methods [21]. However, as hand digging and ploughing was done by many farmers in the Honde Valley, there is likely to be a high degree of soil disturbance, which would impact wetland ecological and hydrological processes.

A variety of leguminous, leaf, and root crops grown in the wetlands ensures nutrient exchange within the soil, and the main commercial crops grown (bananas, yams, and cocoyams) play a vital role in binding the soil together, reducing soil erosion. Similar 'sustainable' crop growing strategies were observed in the Maonazvawo wetland, Zimbabwe, where crop diversification allows the fixing of different nutrients within the soil, and crops such as yams also assisted in reducing soil loss [51]. Soil nutrition retention through the different types of crops also contributes to high yields and promotes social and economic sustainability. The use of leaf litter, crop residue, weeds and compost manure also assists in improving soil texture, which enhances soil water holding capacity and soil fertility (Figure 5). This in turn then reduces crop vulnerability during dry periods, hence improving crop output. Mulching assists in reducing weed growth, soil erosion, and soil compaction and retaining soil moisture. Mixed intercropping also assists in suppressing weeds, reducing soil erosion, controlling pests, and improving crop yields [61].

4.3. Trade-Offs in the Exploitation of Ecosystem Services

The overexploitation of wetlands has always determined the trade-offs between different wetland services [30,31]. However, the overuse of valley bottom wetlands for agriculture has led to increased food production at the expense of other wetland services, such as supporting and regulatory services. Several respondents reported the loss of supporting services and regulatory services, evidenced by the loss of soil fertility, diversion of water due to trench digging, drying up of some parts of wetlands, and gully erosion. Thus, action to increase one ecosystem service can lead to the degradation of one or more other services. This includes an overall reduction in wetland soil fertility and ecohydrological integrity. Optimising the use of valley bottom wetlands for provisioning services came at the expense of biodiversity, where a reduction or loss of some animal and plant species in the wetlands, and an increase and spread of invasive plant species, was reported by some respondents. A study on ecosystem trade-offs on Halu wetland, Israel, also showed optimisation of the wetland for nutrient storage leading to biodiversity loss [62].

The reported drying of some parts of the wetlands may be an unwanted outcome of the trade-off between ecosystem use and reduction some of the available ecosystem services. This may reflect both wetland overexploitation as well as climate change. The deterioration of supporting services due to overexploitation for provisioning services also affects the availability and type of regulatory (climate regulation, water regulation, and sediment retention) and cultural services (Figure 5). This suggests that these different trade-offs should be considered when identifying strategies for wetland management and sustainability [63–65]. As a result of different activities in the wetlands, ecosystem services do not remain static [30]. Activities such as agricultural production disturb the ecological processes and functions of wetlands, which then affect their supporting, regulatory, and cultural services (Figure 5). These feedbacks and trade-offs are critical to understand in order to ensure ecosystem services are available for local communities, especially under climate change, and this requires more detailed insight of local people, their actions and values.

5. Conclusions

Based on the data collected from local communities on valley bottom wetlands in eastern Zimbabwe, this study shows the interconnections and feedbacks between different wetland ecosystem services and how these are valued and used. Regulatory services such as hydrological flows allow for the transport of nutrients essential for crop growth, which in turn result in improvement of supporting services such as soil formation and nutrient cycling, and this then leads to the development of both cultural and provisioning services. This linkage is not well documented in many previous studies, but the results presented here show that complex feedbacks and trade-offs between different services exist, determined by different activities in the wetlands. Although agriculture and food production represent the main provisioning ecosystem service, the role of cultural values and traditions as a mediating factor in ecosystem service use has been previously underplayed. This study shows that understanding the embedded cultural contexts of ecosystem service use, especially by rural communities in the developing world, enables a fuller understanding of ecosystem service provision and vulnerability. Cultural context influences users' decision-making and thus the trade-offs that exist in the use of different ecosystem services.

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Data Availability Statement: Not applicable.

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