

An analysis of the impacts of human activities and management strategies on wetland processes in southern Zimbabwe

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ABSTRACT

Wetlands are one of the most productive ecosystems in the world, as they provide benefits to humans and the environment. Despite their value, wetlands are being degraded at an unprecedented rate. Whilst explanations have been sought from natural and human perspectives, the debate surrounding wetland loss continues, and wetland loss remains a problem, especially in developing countries. A number of strategies on wetland use and management have been developed and implemented at various scales in response to wetland degradation and loss, although spatio-temporal variations were noted, as were varying levels of success, shown to be influenced by differences in existing land use, institutional structures and wetland hydrogeomorphic types. Whilst several studies focusing on specific facets of wetlands have been conducted in Zimbabwe, so far none have been carried out to document the impacts of various land uses and management strategies on wetland conditions. The present study therefore assessed the spatio-temporal impacts of human activities and related management strategies on wetland processes in six wetlands located in three rural districts in the southern part of Zimbabwe so as to address this knowledge deficit.

To achieve the objectives of the study, changing land use patterns in wetlands were assessed for the period between 1985 and 2013 from aerial photographs and RapidEye images; and the benefits derived by surrounding communities determined, complemented by information obtained from household surveys with 123 respondents. Results show that there was no major change in land use as cultivation dominated throughout and increased by only 7.7% between 1985 and 2013. This result prompted the need to assess the impact of cultivation on wetland biophysical conditions (hydrology, geomorphology and vegetation) using the WET-Health framework. Results show that not all, but some cultivation methods negatively affected the present hydrological state of the wetlands. It was observed that broad ridges and broad furrows and concrete canals were largely responsible for drying. Vegetation structure and composition has been seriously modified by cultivation as evident in invasion by non-wetland species.

In order to understand how management strategies influenced use and conservation of wetlands, the study used stakeholders' perceptions to investigate the effectiveness of existing institutional arrangements in regulating wetland protection. The results show that the degree

of wetland protection depends on the number, frequency and relations of institutions operating at each site. Although government departments, traditional leaders, wetland committees and non-governmental organizations participated, generally there was no uniformity in the existing institutional structures at each wetland. Conflicts and discord were sometimes apparent between institutions due to divergent institutional mandates torn between socio-economic and environmental considerations. Traditional leaders and wetland committees were present at each site and where they were effectively involved, wetlands were better conserved as shown by their ecological conditions with little evidence of soil erosion and hydrological alterations as in the case of Chebvuterambatemwa, Dufuya, Madigane and Tugwi.

The study further investigated the gap between policy and practice, especially in light of the new legal dispensation which encourage wise use of wetlands, dating back to 2003. The results show that most of the people (61.8%) were not aware of national wetland law; hence there was a disjuncture between legal provisions and practical implementation resulting in little impact on wetland conservation. Poor implementation of national wetland law may be ascribed to a number of socio-economic factors and institutional challenges. The results of the study further showed that in better conserved wetlands, such as Chebvuterambatemwa, Dufuya and Tugwi, effective soil and water conservation measures were in place and their implementation was effectively monitored by local institutions. Food security of most households adjacent to these wetlands was stable.

Overall, the findings of this study highlighted the importance of understanding the effects of cultivation and related institutional arrangements and policy frameworks on wetland conservation. The study demonstrates the need to adopt a holistic, people-centered approach in wetland management that also considers the environment. The results further provide insights for Zimbabwe to shift towards an integrated approach, to facilitate effective and sustainable utilization of wetlands. It is in this context that this research provides baseline information that can be utilized in the formulation of wetland resources management frameworks based on an understanding of the interaction between anthropogenic, socio-economic and ecological processes.

PREFACE

The present study was carried out with the aim of understanding the spatio-temporal impacts of human activities and the management strategies pertaining to wetlands in rural districts of Zimbabwe and to determine the effect of these impacts on wetland processes. The thesis is based on seven chapters; of which five, excluding the introduction and conclusion, are independent but related conceptualized papers based on the study objectives listed in section 1.4. The five papers, forming chapter two to six, have been prepared for submission to different peer-reviewed international journals; hence the formatting of each chapter is as per requirements of the target journal. Since the chapters have been written as stand-alone manuscripts but with a common thread, some overlap was inevitable in the methods and references of each chapter, and to a lesser extent results. It is, however, argued that this duplication does not detract from the work, as each chapter has its own distinct focus, and considering that these autonomous articles can be read independently without losing the overall context and common thread of the work. The articles making chapters two to six have been submitted to peer-reviewed international journals: one is currently in revision (Wetlands Ecology and Management) and four in review (Transactions of Royal Society of South Africa, Physical Geography, Journal of Environmental Planning and Management and GeoJournal). Although all the articles have been co-authored, I am the primary author with the other authors being the supervisor and/or co-supervisor, as indicated.

- Chapter one is a general introduction and a contextualization of the study.
- Chapter two sets the platform for subsequent discussions by investigating wetland utilization patterns and associated benefits to adjacent communities, (**Marambanyika**, T. and Beckedahl, H. R. Wetland utilization patterns in semi-arid communal areas of Zimbabwe between 1985 and 2013 and the associated benefits to livelihoods of the surrounding communities, *Transactions of the Royal Society of South Africa*. In review).
- Chapter three investigates the extent to which different cultivation methods affect the biophysical conditions of wetlands (hydrology, geomorphology and vegetation). The assessment was guided by the Wet-Health framework, (**Marambanyika**, T., Beckedahl, H. R., Ngetar, N. S. and Dube, T. Assessing the environmental

sustainability of cultivation systems in wetlands using the WET-health framework in Zimbabwe, *Physical Geography*. In review).

- Chapter four assesses the institutional arrangements shaping wetland use and conservation. This was meant to have an in-depth understanding of the ways wetland conservation is regulated in light of continued cultivation, (**Marambanyika, T.** and Beckedahl, H. R. Institutional arrangements governing access, utilization and conservation of wetlands in communal areas of Zimbabwe: Roles, relationships and consequences, *Journal of Environmental Planning and Management*. In review)
- Chapter five examines the policy framework used to regulate wetland management in order to evaluate its adequacy and suitability to ensure conservation of communal wetlands, (**Marambanyika, T.** and Beckedahl, H. R. The missing link between awareness and the implementation of wetland policy and legislation in communal areas of Zimbabwe, *Wetlands Ecology and Management*. In revision).
- Chapter six focuses on strategies implemented by local communities to sustain household food security in light of policy restrictions on wetland use, (**Marambanyika, T.**, Beckedahl, H. R. and Ngetar, N. S. Community strategies to promote sustainable wetland-based food security in rural areas of Zimbabwe, *GeoJournal*. In review).
- Chapter seven provides a synthesis of the research work and exposed lesson learned as well as recommending possible avenues for further research in order to safeguard the ‘kidneys’ of the earth.

DECLARATION 1

The research work described in this thesis was carried out in the Department of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, from March 2012 to December 2015, under the supervision of Prof. Heinz Beckedahl (Discipline of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal; Pietermaritzburg) and Dr. Njoya Silas Ngetar (Discipline of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal; Durban).

I would like to declare that the research work reported in this thesis has never been submitted in any form to any other university. It therefore represents my original work except where due acknowledgments are made.

Thomas Marambanyika Signed: _____ Date: _____

As the candidate's supervisor, I certify the above statement to be correct to my knowledge, and have recommended this thesis for submission.

Signed: _____ Date: _____

Professor Beckedahl (Supervisor)

DECLARATION 2 - PLAGIARISM

I, Thomas Marambanyika, declare that:

1. The research reported in this thesis, except where otherwise indicated, is my original research.
2. This thesis has not been submitted for any degree or examination at any other university.
3. This thesis does not contain other persons' data, pictures, graphs, or other information, unless specifically acknowledged as being sourced from other persons.
4. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
 - a. Their words have been re-written, but the general information attributed to them has been referenced.
 - b. Where their exact words have been used, then their writing has been placed in italics and inside quotation marks, and referenced.
5. This thesis does not contain text, graphics, or tables copied and pasted from the Internet, unless specifically acknowledged and the source being detailed in the thesis and in the references section

Signed _____

DEDICATION

To my beloved wife and two daughters; Tanatswa and Tadiwanashe

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This thesis would not have been completed without the generous help and kind support of many individuals and organizations.

My profound gratitude and heartfelt thanks go to my first promoter and supervisor Professor Heinz Beckedahl; without his skilful supervision, this work could not have been realized. Throughout the entire research, from conceptualization to publication; he provided support, guidance and helped me to clarify my thought. My sincere appreciation and gratitude again goes to my co-supervisor Dr Njoya Silas Ngetar; his diligent guidance, support and assistance in restructuring some chapters of this work is much appreciated.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background

Wetlands are generally described as areas that are periodically or continuously inundated with shallow water or have saturated soils which support vegetation adapted to such conditions (Whitlow, 1989; Matiza, 1992; Mitsch and Gosselink, 1993; Breen *et al.*, 1997; Tooth and McCarthy, 2007). Zimbabwe does not have a home-grown definition of wetlands, but instead adapted the Ramsar definition, and defined wetlands as, “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including riparian land adjacent to the wetland” (Zimbabwe Environmental Management Act, 2003:11).

Wetlands are one of the most productive ecosystems in the world (Mitsch and Gosselink, 1993). The resource provides a wide range of ecosystem services which are critical to human survival and maintenance of the earth with its diverse life forms (Island Press, 2007; Russi *et al.*, 2013). Zimbabwe is endowed with different wetland types which include floodplains, pans, swamps and dambos (ZMENRM, 2010), covering 1.28 million hectares of the total country area (Whitlow, 1984; Matiza, 1992). About 20% of these are located in communal areas (Whitlow, 1985) where population dependence and pressure on natural resources is generally high (Chimhowu *et al.*, 2010). The proportion of wetlands under communal tenure system is increasing as more households are resettled under the ongoing Fast Track Land Reform programme which commenced in 2000.

The existence of wetlands is under threat due to alarming degradation taking place (von der Heyden, 2007). Recent studies estimate that, more than 50% of the global wetlands were lost over the last century (Finlayson and Spiers, 1999; von der Heyden, 2007). Although there is no consolidated figure on the rate of wetland loss in Zimbabwe, rapid degradation dating back to the colonial period has been reported in different parts of the country (Whitlow, 1984; Matiza, 1994; Madebwe and Madebwe, 2005). Wetland degradation and loss is attributed to natural factors (Ngetar, 2011) and mainly human activities, such as agriculture, industrial development, urbanization, pollution and human settlements (Mutyavaviri, 2006; Verhoeven and Setter, 2010; Rebelo *et al.*, 2010). This explains why policies restricting wetland use in most developing countries are based on the known effects of development activities, in particular, agriculture which is the predominant land use (Katerere, 1994; IWMI, 2014).

Efforts to conserve wetlands have been instituted in different countries, but spatio-temporal variations were noted in their degree of success (Maconachie *et al.*, 2008; Dixon *et al.*, 2013). These variations occur in response to diversity in wetland types and socio-cultural and economic status of the local communities as well as governance structures influencing wetland use (Novitzki *et al.*, 1997; Chuma *et al.*, 2008; Day and Malan, 2010), which makes application of homogeneous wetland conservation strategies in different areas difficult (Turner *et al.*, 2000; Maconachie *et al.*, 2008; Dixon *et al.*, 2013). In some cases, it was observed that similar land use type, for example, cultivation, impact differently on wetland ecological conditions, a situation which has been explained in different ways, either from human or natural perspectives (Mbereko, 2008; Rebelo *et al.*, 2010; Ngetar, 2011; Sakané *et al.*, 2011; Marambanyika *et al.*, 2012; Ndiweni and Gwate, 2014). Therefore, it is important to comprehensively examine the socio-cultural context of wetland use and their effects on the biophysical condition of the resource, a situation so far lacking in Zimbabwe.

In sub-Saharan Africa, only South Africa has made progress towards building frameworks for effective wetland management based on an overall picture embracing human and natural factors (Macfarlane *et al.*, 2008; Kotze, 2010; Turpie, 2010). Therefore, there is a gap in information required for planning and achieving sustainable wetland management in Zimbabwe, a problem also identified by Frenken and Mharapara (2002). Literature revealed that more site-specific research based on analyses of socio-ecological complexities is required, if wetlands of different types are to be protected and their value maintained (Novitzki *et al.*, 1997; USEPA, (2001), but so far, this has not been done in Zimbabwe. Since Zimbabwe joined the Ramsar Convention in 2013, it is critical to provide some baseline information which the country can rely on to meet the provisions of this international convention on ‘wise use’.

1.2 Wetland management in the Zimbabwean context: Approach and challenges

A dual arrangement involving traditional and modern institutions exists in wetland governance in Zimbabwe, although the effectiveness of this arrangement has been questioned in most sub-Saharan African countries (Rebelo *et al.*, 2010). Meanwhile, wetland loss continues despite existence of regulatory policies and institutional frameworks, which restrict

use of wetlands for certain purposes worldwide (Ma *et al.*, 2013; Russi *et al.*, 2013; Zheng *et al.*, 2014) and Zimbabwe is no exception. In light of rapid loss of wetlands due to human use, mainly for agriculture in communal areas, a number of successive pieces of legislation were crafted to solve the problem in Zimbabwe. These include colonial legislation such as the Water Act (1927 revised 1976 and 1998), the Natural Resources Act (1941), the Public Streambank Protection Regulation (1952) and the Land Husbandry Act (1951). However, the success of these Acts which prohibit cultivation has been viewed as limited, as wetland loss from this activity continued (Owen, 1994). The failure of wetland law was largely attributed to its ignorance of human aspects of conservation (Katerere, 1994; Chingwenya and Manatsa, 2007).

The colonial laws continued into the first two decades of post-independence period until the enactment of the Environmental Management Act (EMA Act) (2003). The EMA Act champions sustainable utilization of wetland resources, by incorporating the public in the use and conservation, although with some restrictions for certain activities, such as draining and introduction of alien species. However, most of the activities, such as cultivation, which are supposed to be implemented with permits as expected under the EMA Act, are still taking place without fulfilling this prerequisite legal requirement. So far, no research has been conducted to assess the effect of change in legal requirements on both wetland conditions and management, despite the fact that the country is searching for solutions to address issues of sustainability in the wetlands. It was observed that sustainable land management can be achieved by collectively addressing ecological, social and economic attributes of targeted natural resource (Liniger *et al.*, 2011).

Notwithstanding the fact that natural resource use and management are inextricably linked (Mukamuri *et al.*, (2009), little research attention is paid to collaboration of various institutions in management of individual wetlands in order to achieve sustainable wetland utilization. In fact research in Zimbabwe is mainly centred on how to enhance use of wetlands, especially for agriculture (Mutambikwa *et al.*, 2001; Taruvinga, 2009) with no meaningful follow-up on the environmental sustainability of agriculture and other human activities in light of existing governance structures. Despite the fact that global debate on effects of human activities and management strategies on wetland processes is ongoing, the

extent to which wetland processes have been impacted by human use and related management strategies in Zimbabwe remains unclear and this calls for further research.

1.3 The research problem

As discussed in the preceding sections, wetland loss continues in communal areas of Zimbabwe. This situation compelled me to examine, from human and natural standpoints, why despite change in legislative framework towards sustainable wetland conservation, wetland degradation persists. The study is framed in the context of Shine and de Klemm (1999)'s proposal that successful use and management of wetland ecosystem can be achieved if the relationship between people, wetlands and human institutions is understood by wetland users, planners and policy makers. So far, to the best of my knowledge, no research, has tried to comprehensively demonstrate the interlinkages between wetland health, land use and governance structures in Zimbabwe, although these factors are known to act in combination as they determine wetland conservation.

Some previous studies on wetlands focused on agronomic activities (Mujaju *et al.*, 2013), pollution (Masaka *et al.*, 2014), review of existing policy without assessing its effect on wetland conditions (Katerere, 1994), and general understanding of social organizations (Mberek0, 2008), but shunning the nested approach critical for wetland management. This makes effective generalization and application of results through policy questionable. Failure to understand complex socio-ecological interactions within wetlands may result in missing the bigger picture responsible for wetland degradation (Gardner and Davidson, 2011). This research will lay a foundation towards devising an integrated strategy for location-specific sustainable wetland management in Zimbabwe. An integrated management strategy in the context of this work involves understanding the holistic interaction and impact of human societies on wetlands. Sustainability in the context of this research is defined as a situation when the quality of human life is improved within the carrying capacity of the supporting wetland ecosystem.

1.4 Overall study objectives

The aim of this study was to investigate the spatio-temporal impacts of human activities and the management strategies pertaining to wetlands in Vungu, Tongogara and Runde rural districts of Zimbabwe and to determine the effect of these impacts on wetland processes.

The specific objectives in this study were as follows:

1. To assess changing land use patterns in wetlands and the benefits derived from wetland to surrounding communities in rural areas.
2. To assess the effects of land use on wetland biophysical conditions, using the WET-Health system (Macfarlane *et al.*, 2008).
3. To assess the implications and consequences of formal and informal institutional arrangements related to access and utilization of wetlands by local communities.
4. To investigate the gap between policy and practice on wetland use and conservation in rural communities.
5. To analyze coping strategies to mitigate the effects of land use on wetlands yet support rural communities in food security.

1.5 Description of the study area

The study was conducted at six wetlands located in Tongogara, Runde and Vungu rural districts of the Midlands province, Zimbabwe (Figure 1.1; Table 1.1). Two wetlands were selected from each district through a reconnaissance survey aided by a wetlands inventory obtained from the Environmental Management Agency of Zimbabwe, to understand the spatial variations in wetland conditions, use and management. The selection of the six wetlands was based on the current level of wetland utilization, the differences in utilization methods and the observed differences in the current state of the wetlands. The selected wetland sites for study are Dufuya (19°17'S and 29°21'E) and Madigane (19°15'S and 29°15'E) (Vungu Rural District Council (RDC)), Guruguru (19°56'S and 30°03'E) and Tugwi (19°36'S and 30°18'E) (Tongogara RDC), and Chebvuterambatemwa (20°19'S and 30°01'E) and Zungwi (20°29'S and 30°20'E) (Runde RDC).

Chebvuterambatemwa, Dufuya, Madigane and Tugwi are permanent wetlands as they are submerged throughout the year. Guruguru and Tugwi are inundated for varying lengths of time; hence they are generally considered as seasonal wetlands. Chebvuterambatemwa, Dufuya and Madigane can be classified as channelled valley bottom; Guruguru and Zungwi, as unchannelled valley bottom and Tugwi as a floodplain (Ellery *et al.*, 2009). These hydrogeomorphologically diverse wetlands are found in Zimbabwe's Middleveld between

970 and 1300 m above sea level, and are located in the Runde River basin which supplies water to sugarcane estates in the Lowveld area of the country. Hence the sustainable use of these wetlands does not only have local significance, but also have broader-scale implications given the economic importance of sugar production to Zimbabwe and the southern Africa region.

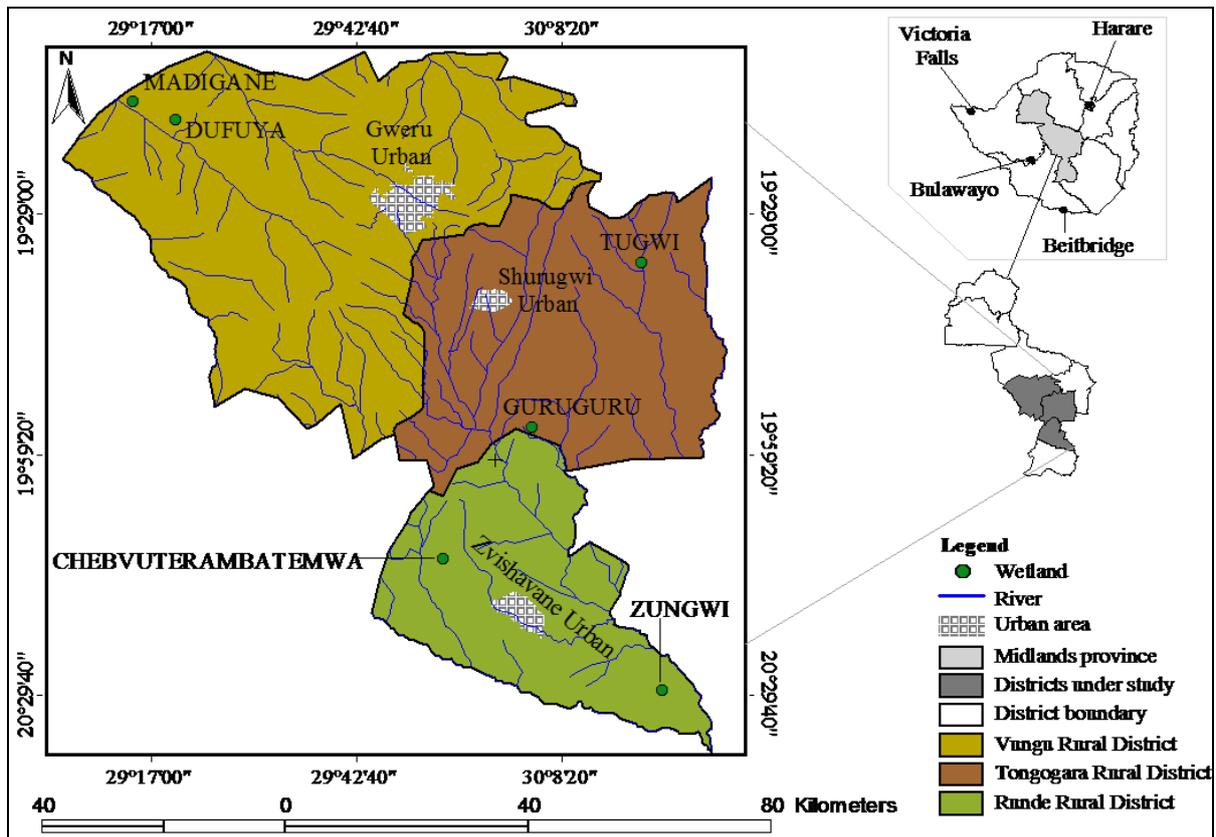


Figure 1.1: Map showing the location of wetlands studied within three districts of Midlands province, Zimbabwe

Zimbabwe is divided into natural farming regions (also known as agro-ecological zones), a classification of the agricultural potential, based on rainfall, soil quality and vegetation (Vincent and Thomas, 1960; Mugandani *et al.*, 2012). The regions range from one (with an annual average rainfall total above 1000 mm) to five (with less than 450 mm per annum). Chebvtuterambatemwa, Zungwi, Dufuya and Madigane wetlands are located in natural farming region four which receives annual average rainfall total ranging between 450 - 650 mm whereas Guruguru and Tugwi are found in natural farming region three receiving average annual rainfall total between 650 - 800 mm.

The climate of the districts, where wetlands under study are found, is predominantly tropical savannah, characterised by a dry winter season from mid-April to end of October and a wet summer season from November to early April, punctuated by a mid-season dry spell, frequent droughts and unreliable start of rains (Lister, 1987, Mugandani *et al.*, 2012). The rainfall pattern is effectively seasonal, being influenced by the migration of the Inter-Tropical Convergence Zone. The average temperatures range between 8 and 21°C in winter and 23 and 33°C in summer. The aridity index of the districts is low as the mean annual potential evapotranspiration (PET) is higher than mean annual precipitation (MAP) (FAO, 2006).

Zimbabwe is broadly divided into four major geomorphic provinces, each exhibiting its own distinctive geomorphology. The study area is found in the Central Axis region (Lister, 1987), located on the country's main watershed. The districts are characterised by poor soils, derived from underlying granitic rock (Scoones, 1990; Madebwe and Madebwe, 2005), with low pH and poor water holding capacity (FAO, 2006). Tongogara and Vungu RDCs are dominated by Kalahari sands (arenosols) which are highly permeable, whereas Runde district is characterised by luvisols (Nyamapfene, 1991). The soils' erosion hazard is rated as medium (arenosols) and variable (luvisols) (FAO, 2006). Miombo woodland, dominated by *Julbernardia globiflora*, *Terminalia sericea* and *Brachystegia* species is the common vegetation type, with annual grasses such as *Eragrostis* species (Ngorima, 2006; Matsa and Muringaniza, 2011).

Human population has been increasing in households adjacent to wetlands (Table 1.1). The average household size in Wards where wetlands under study are located varies between four and five persons. Females constitute 53.9% of the entire population due to high rates of male out migration in search of employment (Zimstat, 2012). Shona-speaking people dominate in Runde and Tongogara RDCs whilst Vungu RDC is in Ndebele-speaking area. The two ethnic groups (Shona and Ndebele) are the largest in the country; hence the research findings can be largely generalized to some parts of the country where wetlands were used under these socio-cultural contexts.

Table 1.1: Wetland location, and history of population size, number of households and percentage change of household numbers (Source Zimstat)

District	Ward	Wetland name	Population size			Number of households			Percentage change of household numbers	
			1992	2002	2012	1992	2002	2012	1992-2002	2002-2012
Tongogara	9	Guruguru	2975	4153	4643	555	923	1081	66.3	17.1
Tongogara	1	Tugwi	4951	2653	3524	931	446	707	-52.1	58.5
Runde	11	Chebvute*	3303	3118	2999	585	645	651	10.3	0.9
Runde	17	Zungwi	5113	5734	5617	915	1154	1191	26.1	3.2
Vungu	2	Dufuya and Madigane	5722	6625	4972	961	1320	1096	37.4	-17.0

*The name in full is Chebvuterambatemwa

The predominant farming system is smallholder agriculture (FAO, 2006). Local people grow drought-tolerant varieties of maize, millet and sorghum, especially in region four with semi-arid conditions, ideally suitable for wildlife and cattle production under extensive production systems. Agricultural yields from dry lands are generally low due to poor soils and the risk of crop failure is fairly high due to high rainfall variability (Mazvimavi, 2010; Mugandani *et al.*, 2012). The majority of households cannot meet their annual food requirements even in normal rainfall seasons (Agritex Report, 2010). This situation provides a motivation for the study to examine the contribution of wetlands to rural livelihoods, the effect of land use types on wetland health and suitability of existing institutional and policy frameworks. Other livelihood options for the people include short contract work (piecework), gold panning and livestock rearing and selling. Large-scale platinum and diamond mines such as Unki, Todal, Mimosa and Murowa also provide employment opportunities.

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CHAPTER TWO

WETLAND UTILIZATION PATTERNS AND THE ASSOCIATED LIVELIHOOD BENEFITS IN SEMI-ARID COMMUNAL AREAS OF ZIMBABWE

2.1 Introduction

Zimbabwe, despite being a dry country in global terms with a mean precipitation of 692 (Sweeney 2011), is endowed with different wetland types which include floodplains, pans, and dambos; which is the predominant type (Feresu et al 2010). Dambos are seasonally waterlogged valleys or depressions with herbaceous vegetation, mainly grasses and sedges, and an absence of trees (Acres et al 1985; Whitlow 1989). Dambos, which are locally known as '*bani*' or '*dekete*' or '*matoro*' (Shona language) and '*inuta*' or '*amaxhaphozi*' (Ndebele language), occupy about 3.6 percent of the total land area of the country (Frenken and Mharapara 2002).

In developing countries, wetlands continue to be lost mainly due to unsustainable human activities driven by communities' high dependence on natural resources for livelihoods (Feresu et al 2010; Frenken and Mharapara 2002; Katerere 1994; Van Rees and Reed 2014; von der Heyden 2007). However, there has been debate on the extent various human activities affect wetland morphology and whether the full value of wetlands to societies is known. This discussion has been necessitated and sustained by the fact that, fragile as they are, wetlands have historically been the basis of human survival due to availability of water, biodiversity and sometimes fertile soils (Matiza 1992; Mitsch and Gosselink 1993), a situation likely to persist into the foreseeable future.

Although economic valuation of natural resources has been on-going worldwide (e.g. Cavendish 2000; Thondhlana et al 2012), there is very little information on wetlands in resource poor countries in sub Saharan Africa, except South Africa. Therefore, wetlands are partly lost because their full value to society is not taken into account in the planning process for both development and conservation (Dugan 1992). Thondhlana et al (2012) on the other hand highlighted the importance of natural resources valuation. It provides empirical evidence of community use and dependence on natural resources as well as implications of constrained access, information that can be factored in conservation planning for sustainable development.

Meanwhile, wetland conditions also present certain challenges such as diseases (McCartney et al 2005, von der Heyden 2007). These problems result in wetlands being regarded as

wasteland not worthy of management (Msipa 2009). This perception partly explains why until relatively recently, there was little regard of wetlands on policy agendas in southern Africa including Zimbabwe (Breen et al 1997) and their subsequent regression in quantity and quality due to mismanagement (Mutepfa et al 2010). However, where the value of wetlands is known, they are regarded as “wealthlands” because of their incalculable value (Lee 1999).

McCartney et al (2005) estimated the global economic value of wetland goods as US\$70 billion a year. The services delivered by wetlands globally have been arguably valued at US\$14 trillion annually (Ramsar Convention Secretariat 2010). In Zimbabwe, very few attempts were made to evaluate the value of wetland goods and services resulting in little appreciation of the resource at all levels of the society (Ministry of Environment and Natural Resources Management 2010). Most studies carried out mainly focus on crop productivity in wetlands (Mujaju et al 2013; Taruvinga 2009; Svatwa et al 2008) and tended not to include their value in flood mitigation, erosion control and water retention. The global picture of wetland values, however, portrays the general importance of this fragile resource to human survival. Understanding of wetland values to society and economy is therefore crucial for their sustainable management as this can help to inform relevant policy development and facilitate commitment to its fulfilment (Russi et al 2013; Mutyavaviri 2006; Mukahanana 1994), especially in developing countries where dependence on natural resources is an imperative rather than a choice.

It is important to note that wetland values are not static but dynamic in response to social, cultural, economic and environmental changes. The United States Environmental Protection Agency (2001) emphasises the need to periodically determine the value of individual wetlands given their diverse types and socio-cultural context of use. It was realized that values assigned to wetland may change over time as its ecological state and societal perceptions and priorities change (Novitzki et al 1997). Therefore, the spatio-temporal value attached to a wetland needs to be understood as it determines its use, contribution to people’s livelihood portfolios and conservation, information important in steering decisions that can minimize unsustainable use of wetlands (Turpie 2010).

It is within the scope of this study to examine whether wetland utilization patterns and livelihood are associated with changes in land cover and land use in six wetlands located in three districts of the Midlands province, Zimbabwe; occupied by Shona and Ndebele ethnic groups. According to Thondhlana et al (2012), understanding of uses and values of natural resources across socially differentiated groups, as well as underpinning factors, is required to design equitable and effective sustainable natural resources use systems in conservation areas. The specific objectives of this research are threefold: (1) to assess land cover/land use changes in selected wetlands between 1985 and 2013 from high resolution datasets, (2) to establish factors influencing wetland utilization patterns and benefits over the past three decades, and (3) to assess households' current level of economic dependence on wetlands using income as an indicator.

2.2 Materials and Methods

2.2.1 Field data collection

Field survey was carried out between July and October 2013 using questionnaires and semi-structured interviews to gather information on wetland utilization patterns. In keeping with the generally accepted benchmark for population sampling (Nyariki 2009), the sample size for the questionnaire survey constitutes 10% of the households in the wetland areas studied. Therefore, a total of 123 questionnaires were proportionally administered to household heads (or eldest person who make decisions in the absence of head) selected using a stratified random technique as shown in Table 2.1. Selection of households from villages representing the sampling frame in each wetland area was done using random number table and the community register. In this case, households were assigned numbers on the register, and were picked following rules of random number tables. Only villages with households utilizing wetlands or aware of wetland history due to their proximity formed the sampling frame.

Table 2.1: Sampling sites shown in Figure 1 and sample size in relation to total number of households

Rural District	Wetland name	Number of villages around the wetland	Total number of households in the villages	Sample size (10%)
Vungu	Dufuya	6	199	20
Vungu	Madigane	7	280	28
Tongogara	Tugwi	7	111	11
Tongogara	Guruguru	5	172	17
Runde	Chebvuterambatemwa	9	246	25
Runde	Zungwi	8	223	22
Total		42	1231	123

Household heads provide information on socio-economic characteristics of households (e.g. size, age of head, sources of income etc.), type, quantity and use of natural resources harvested, land use type and degree of benefits, factors influencing wetland utilization patterns, level of households' dependency on wetlands using estimated income as an indicator and the influence of acquired benefits on resource conservation. The goods obtained were recorded and valued using local market prices. Mean annual household incomes were obtained by adding all income from household members; regardless of whether the source is formal or not. Both wetland income and total household income were extrapolated over 12 months to get yearly averages.

A second questionnaire was designed to target teenagers, so as to establish their knowledge on wetland use and benefits. Teenagers' views in this research were important since they are future custodians of the resource. On average 10 teenagers were selected (using purposive sampling) from the targeted villages around each wetland, giving a total of 60 respondents. The questionnaires were drafted in English and translated into local languages. The questionnaires were pretested for validity, reliability and acceptability through a pilot survey. In this case, a field test was conducted with ten household heads and five teenagers randomly picked around a wetland with similar use but not among the six targeted. The pilot wetland was located in Vungu RDC where major ethnic groups (Shona and Ndebele) represented in the three districts were found. Questionnaires were self-administered to ensure that the responses are from the intended subjects, and safeguard a high response rate.

Twelve elderly, lucid people above the age of 70, two from the villages surrounding each of the six wetlands were selected for semi-structured interviews through snowballing sampling

in order to tap their institutional memory on wetland utilization patterns. Snowball sampling method was used since elderly population represent a small fraction of the underlying target population; which makes it difficult to identify or distinguish homesteads with an elderly person. Since the sampling technique relies on referrals, the first elderly person was identified with the assistance of the local traditional leader with background knowledge of people in the area. This elderly person then referred the researchers to the second target person in each wetland. Interviews were audio recorded and notes were taken at the same time to capture important cues and relevant points. Participants' consent was sought before responding to questionnaires and interviews.

2.2.2 Data analysis

Quantitative data generated through questionnaires was coded and analysed using Statistical Package for Social Scientists (SPSS) Version 16 at 95% Confidence Interval (CI). Normality test was first conducted using Kolmogorov-Sminov test to determine whether a parametric or non-parametric test should be used. Wilcoxon test was used to compare annual household wetland income and total household expenditure. The comparison was done to determine households' level of dependency on wetland using income as an indicator. Spearman's rank correlation coefficient test was used to show the nature of relationship between wetland income and variables such as household size, age of household head, period of wetland use, distance to and fro wetland and travelling time. Chi-square test was used to determine the association between influence of wetland benefits to people's attitude towards resource conservation and households' socio-demographic characteristics. In this study, it was assumed that socio-demographic characteristics of households have a bearing on income generation and use, and conservation of natural resources.

Qualitative data generated through open-ended questions in questionnaires and semi-structured interviews was subjected to content analysis (Kohlbacher 2006), whereby emerging categories from data (e.g., on nature of benefits, factors influencing use patterns etc.) were quantified and presented in tabular format. Rainfall data obtained from Meteorological Services Department of Zimbabwe (to determine trends) for period 1979 to 2013 was subjected to regression analysis performed in a Microsoft Office Excel 2007. This was done to determine if there is significant change in annual rainfall totals for each district, a

situation which may influence trends and level of wetland use in these communities dependent on rain-fed dryland agriculture. Zimstat statistical data was used to show population trends for period 1992 to 2012.

2.2.3 Remote sensing image selection and acquisition for land cover change detection

Wetland cover changes in response to human utilization patterns were detected through imagery analysis for the period 1985-2013. The period under review include major socio-economic changes which occurred in the country that had both a direct and an indirect bearing on wetland use and conservation, such as land reform, economic structural adjustment programme (ESAP) and economic crisis since the turn of the 21st century. 5-m RapidEye images and aerial photographs (Table 2.2) were used since the focus was on small wetlands which required imagery of high resolution as observed by Halabisky and Moskal (2009). Given compatible spatial resolution to aerial photography, almost similar classes of features can be extracted from high-resolution satellite imagery (Halls and Kraatz 2006). All images used were taken during the dry season (June-September), a period when wetlands were visibly distinct compared to the surrounding dry areas. The use of high resolution images to analyse land cover and land use change detection in small wetlands of Zimbabwe has not been done in the past. The previous researches on wetland mapping used low resolution images like Landsat which often neglected small wetlands despite their importance to local communities.

Table 2.2: Sources of images used in the analysis

Place	Date of acquisition	Type of imagery	Spatial resolution /Photo scale
Dufuya	26/09/2013	RapidEye	5m
Dufuya	13/08/1996	Aerial photo	1:50000
Dufuya	22/06/1985	Aerial photo	1:25000
Madigane	17/09/2013	RapidEye	5m
Madigane	13/08/1996	Aerial photo	1:50000
Madigane	22/06/1985	Aerial photo	1:25000
Chebvute	30/09/2013	RapidEye	5m
Chebvute	08/08/1985	Aerial photo	1:25000
Chebvute	12/08/1996	Aerial photo	1:50000
Zungwi	30/09/2013	RapidEye	5m
Zungwi	20/09/1997	Aerial photo	1:50000
Zungwi	12/06/1985	Aerial photo	1:25000
Guruguru	30/09/2013	RapidEye	5m
Guruguru	15/08/1996	Aerial photo	1:50000
Guruguru	22/07/1985	Aerial photo	1:25000

2.2.4 Pre-processing, processing and analysis of images used

Three RapidEye images were acquired with atmospheric, geometric and radiometric corrections already applied. All RapidEye images were already ortho-rectified to meet an accuracy of 6m using ground control points and fine digital elevation models (DEMs). Aerial photographs were obtained from the Department of Surveyor General Zimbabwe in analog (hard copy) format which required scanning and rectifying. Scanning of aerial photographs using a Colortrac's smartLF Gx+42 wide format scanner was done at 400dpi, which was sufficient for the scale and interpretation of the wetlands (Halls and Kraatz 2006; Linder 2003). Unlike digital satellite images which offer a fixed spatial resolution, using aerial photographs allows to influence the information content of the images through photoscale and scanning pixel size (Grabmaier et al 1996). All aerial photographs were later re-sampled to 5 m resolution of RapidEye images using the nearest neighbour assignment technique. This technique is important in that it does not alter the image pixel information (ESRI 2007).

Scanned aerial photographs were geo-referenced using 1:50 000 topographical maps as reference in Erdas Imagine 9.1. The 1996 aerial photographs were geo-referenced first and later used as base images to geo-reference the 1985 photographs. The coordinate system employed for all images was the Universal Transverse Mercator (UTM) map projection using ARC1950 as the Datum. Co-registration of RapidEye images and aerial photographs was done using 1996 aerial photographs as base images in ENVI 4.7. Images were masked in Envi 4.7 to focus and cover the desired wetland sites.

Supervised classification of multi-temporal images was done using the Maximum Likelihood Classifier in ENVI 4.7 to detect changes in wetland cover assumed to be a function of land use type and land use change. Accuracy assessment was performed through a confusion matrix. Land utilization in the wetland was categorized into the following major classes; dense vegetation, sparse vegetation, bare land, water and cultivated. Training sites established for fieldwork aided the establishment of classes as well as supervised classification. Computation of statistics through image differencing was done so as to show spatial and temporal changes in land cover/land use.

2.3 Results and discussion

2.3.1 Land use/Land cover changes in wetland areas

Cultivation is the predominant land use type in the wetlands since 1985 (Table 2.3). Generally, the area under cultivation has been increasing from 1985 to 2013. Cultivation was practised on 53.4 ha of the total wetland area in 2013 compared to 49.6 ha in 1985, representing a 7.7% increase over three decades. The spatio-temporal increase in cultivated area was confirmed by 66.67% of the households and 18.3% of teenagers. Households practice either horticulture or cereal farming in wetlands. Agricultural expansion is therefore the major economic activity taking place in the wetlands, a situation also confirmed in other developing countries by Rosolen et al (2014) and Zsuffa et al (2014). The increase in wetland cultivation may be attributed to the integral role agriculture plays in rural livelihoods of semi-arid areas in Zimbabwe (Vitoria et al 2012).

Table 2.3: Land cover/Land use change in wetlands of the study area (measured in hectares and proportion of change in percentages) between 1985 and 2013

Landuse type /Landcover	Time series			Change in percentage (%)	
	1985	1996	2013	1985-1996	1996-2013
	Coverage (Ha)				
Water	0.8	0.7	0.9	-12.5	28.6
Bare land	11.0	14.3	31.9	30	123.1
Cultivated land	49.6	44.4	53.4	-10.5	20.3
Sparse vegetation	45.6	44.3	27.4	-2.9	-37.7
Dense vegetation	21.3	24.6	14.7	15.5	-40.2

The spread of cultivation over the years, for example by 20.4% between 1996 and 2013, was accompanied by loss in vegetation cover as evidenced by a decrease in both sparse and dense vegetation (Table 2.3). This finding is somehow similar to Dube and Chitiga (2011)'s observation that cultivation in wetlands of Zimbabwe reduce the areal extent of vegetation cover, composition and species diversity, an indicator that wetlands are being modified. Therefore, expansion of wetland cultivation result in loss of vegetation which assists in provisioning of ecosystem services such as wild food, flood attenuation and erosion control. Results of this study are therefore in line with some previous studies (Musamba et al 2011) which argued that conversion of wetlands to cultivation may lead to reduction in its areal extent together with wetland values.

The increase in cultivated area and decrease in vegetation is also attributed to the growth in number of people establishing and extending gardens on the fringes and within wetlands. This was revealed by 53.7% of households and 73.3% of teenagers. Population trends in the studied areas also show an increase in the number of people and households (Table 2.4). This may suggest that more pressure is being exerted on the resource as demand for productive land maybe increasing (Svotwa et al 2007) as people thrive to enhance livelihood options under semi-arid conditions. However, in Ward 2 of Vungu RDC where Dufuya and Madigane wetlands are located, there was a 17% decrease in number of households between 2002 and 2012 (Table 2.4). This was attributed to the effect of land redistribution. Some households relocated to new resettlement areas in the nearby districts of Kwekwe and Insiza.

Table 2.4: Changes in population size and number of households in Wards housing wetlands under study, between 1992 and 2012 (Source: Zimstat)

District	Ward	Wetland name	Population size			Number of households			Percentage change of household size	
			1992	2002	2012	1992	2002	2012	1992-2002	2002-2012
Tongogara	9	Guruguru	2975	4153	4643	555	923	1081	66.3	17.1
Tongogara	1	Tugwi	4951	2653	3524	931	446	707	-52.1	58.5
Runde	11	Chebvute*	3303	3118	2999	585	645	651	10.3	0.9
Runde	17	Zungwi	5113	5734	5617	915	1154	1191	26.1	3.2
Vungu	2	Dufuya and Madigane	5722	6625	4972	961	1320	1096	37.4	-17.0

*The name in full is Chebvuterambatemwa. Note that a decrease in population size and number of households in Ward 1 Tongogara RDC between 1992 and 2002 was caused by changes in administrative boundaries.

However, the relocation of these households did not reduce land under cultivation in the two wetlands. Instead cultivated area increased by 3.3% and 63% between 1996 and 2013 for Dufuya and Madigane wetlands respectively. The abandoned plots were immediately occupied by new users who were previously excluded due to limited cultivation space in and around wetlands or old farmers expanded their plots since on average each household was utilizing 200 m², an area viewed by many as inadequate to generate sufficient household food and income for an average family of 5.9 persons. Therefore, despite resettlement of people, population pressure on Dufuya and Madigane wetlands and their resources is still immense. These results are similar to those of studies conducted by Madebwe and Madebwe (2005), Mbereko (2008) and Musamba et al (2011) who argued that population growth result in

cultivation expansion which diminish wetland ecology, resulting in direct or indirect loss of ecological values such as habitat for wildlife and possibly sink for atmospheric carbon.

The expansion of gardens is sometimes orchestrated by politicians who allocate plots for political expediency, a situation more common in Madigane (Table 2.5). This finding is similar to that of Zheng et al (2014) in China that wetland conservation is also given a low priority when local officials made politically driven decisions. Therefore, political ambitions and considerations remains an obstacle to protection of wetland ecology and preservation of benefits in developing countries. Meanwhile, halting wetland development for agriculture is difficult since livelihood opportunities are limited as 91.9% of the household heads were not formally employed, hence primarily earn a living from own agricultural production. Limited livelihood opportunities for wetland users were also identified by Rebelo et al (2010) as a factor sustaining continuation and expansion of cultivation in wetlands.

Meanwhile, there is progressive increase in bare land as evidenced by an increase of 123.1% between 1996 and 2013. Bare land occupied 24.9% of the wetland area in 2013 compared to 8.6% in 1985 (Table 2.3). This is an indicator that the wetlands are shrinking in size. Evidence from analysed satellite images show that the fringes of wetlands are bare and the condition has been encroaching into the wetlands, a situation confirmed by 64.3% of households and all interviewed elderly people. Desiccation of wetland fringes prompted households to abandon old cultivated lands and extend cultivation into the wetland. Rivers-Moore and Cowden (2012) revealed that the presence of bare area is an indicator of wetland degradation.

The decline in wetland vegetation and increase in bare land was also attributed to livestock grazing by 24.4% of the households and 18.3% of teenagers. This may be true as livestock population, in particular cattle, per household has been increasing. On average each household had five cattle in 2013 compared to three in 1990. This represents an increase of 66.7% in livestock population in the last two decades. According to Musamba et al (2011), wetlands provide a suitable pasture for livestock grazing as well as a perennial source for livestock watering, a potential situation which may contribute to wetland degradation. It is important to note that livestock forms an integral component of rural households' wealth;

hence are vital to sustenance of their socio-economic activities including income generation for basic needs. Therefore, use of wetlands for grazing is likely to persist.

The abovementioned situation implies an increase in livestock demand for pasture and water in wetlands given the prevailing semi-arid conditions in the districts. A study by Musamba et al (2011) at Lake Victoria revealed that a marginal increase in livestock size have negative impacts on wetlands. Studies conducted by Dahwa et al (2013), Morris and Reich (2013) and Sibanda (2005) also indicate that increased livestock grazing leads to treading, soil compaction, a decline in plant species and increase in bare land. This common position however contradicts Marty (2005)'s findings in ephemeral wetlands of California that cattle grazing allow native vegetation to flourish and minimize proliferation of exotic species. However, the common understanding in the aforementioned studies is that livestock population size should be monitored for them not to be destructive.

In most instances the reduction in rainfall is associated with wetland desiccation (Barros & Albernaz, 2014). Correlation results demonstrated an increase in rainfall in Runde RDC ($r^2 = 0.0063$; $y = 1.4628x+511.64$), and decreases in Tongogara RDC ($r^2 = 0.0377$; $y = -5.5422x+940.11$) and Vungu RDC ($r^2 = 0.0314$; $y = -5.2576x+936.69$) between 1979 and 2013. Therefore, drying of wetlands and increase in area covered by bare land may be more linked to anthropogenic activities such as increased cultivation through artificial drainage and channeling as people want to improve their livelihoods.

Wetland area covered by water increased by 28.6% over a period of 17 years, between 1996 and 2013 compared to the previous period 1985-1996, when a decrease of -12.5% was experienced. Meanwhile, it appears as if there is a relationship, although not statistically validated, between decline and/or increase in area covered by dense vegetation and water (Table 2.3). When dense vegetation decreased for period 1996-2013, the area covered by water marginally increased; though the proportion of change is not identical. The clearance of vegetation could have resulted in more water being exposed to the surface. The inverse scenario is almost true for period 1985-1996, when presence of more dense vegetation was associated with less water visible on the ground as shown by the spectral signatures of the two variables.

2.3.2 Factors influencing wetland utilization patterns

The majority of the households (59.3%) indicated that there is no change in wetland utilization patterns over the past three decades as agriculture remains the predominant activity. Cultivation was identified as the major landuse practice followed by livestock grazing. This result partly contradicts findings of Svatwa et al (2008) who revealed that wetlands were largely used for livestock grazing than cultivation in Zimbabwe. The differences in agro-ecological conditions of wetlands may explain the differences in significance of agricultural practices type instituted.

Svatwa et al (2008)'s research was conducted in natural farming region one where average rainfall amount exceeds 1000 mm compared to the current study located in semi-arid environment receiving less than 650mm. Therefore, the use of wetlands for cultivation is driven by presence of moisture in semi-arid areas of Zimbabwe. However, the dominance of cultivation and livestock rearing in wetlands confirms the notion that agriculture remains the backbone of rural livelihood strategies, as confirmed by Vitoria et al (2012) that more than 70% of the rural poor still depend on agriculture for food, income and employment.

However, 40.7% of the households and 85.7% of elderly population revealed that land use type in wetlands has been changing. Instead of relying on wetlands solely for agricultural produce, wetlands used to have socio-cultural significance. Local people used to perform traditional rituals such rain-making ceremonies, harvest fruits and reeds, hunt wildlife, collect traditional vegetables and herbs and fishing. These socio-cultural and economic values associated with pristine wetlands are largely lost today due to spread of cultivation in response to increasing human pressure. For instance, Guruguru and Zungwi wetlands were transformed into agricultural fields under the broad ridges and broad furrows (BR/BF) project implemented through partnership between donors and local people meant to increase food supply (Table 2.5). Conversion of pristine wetlands to farmlands has also been identified in previous research (Svatwa et al 2008; Sibanda 2005) as a major factor undermining range of wetland benefits in most developing countries as direct use values are reduced.

Table 2.5: Households' views (in percentages) on factors influencing wetland utilization patterns, as measured by responses to a questionnaire survey

Reason	Madigane (n=28)	Dufuya (n=20)	Chebvute (n=25)	Tugwi (n=11)	Zungwi (n=22)	Guruguru (n=17)	Total (n=123)
Political interference	21.5	-	-	-	-	11.8	6.5
Declining rainfall	85.7	90	72	100	54.6	58.2	75.5
Erection of protection fence	17.5	40	8	54.6	4.6	-	19.9
Generations change (Beliefs change)	-	-	8	-	18.2	-	4.9
Provision of inputs by donors	53.6	15	16	81.8	81.8	94.1	40.7
Decline in soil fertility of arable dryland	10.7	5	16	-	-	-	6.5
Vandalism of protection fence	-	-	-	-	63.6	94.1	24.4
Wetland mismanagement	-	-	20	-	31.8	29.4	13.8
Market availability for horticultural products	82.1	65	8	-	-	-	30.9

*Note that some respondents indicated more than one influencing factor.

Cultivation in wetlands is influenced by declining rainfall for dryland farming and a decline in soil fertility of arable fields as indicated by 75.5% and 6.5% of households respectively. These perceptions may confirm findings by Acres et al (1985) that wetland conditions in some cases provide fertile soils and wet conditions suitable for farming almost throughout the year. In that respect, local people are cushioned from food shortages before dryland harvests and during drought periods. However, analysed rainfall data shows statistically insignificant changes in rainfall amounts as discussed earlier. According to Mazvimavi (2010), the general perceptions on declining rainfall are influenced by the presence of multidecadal variability in Zimbabwe instead of statistically significant change in rainfall totals.

Moreover, donors are promoting wetland cultivation by assisting local people in the implementation of wetland-based food security projects. Non-governmental organizations (NGOs) provide fencing material, distribute farming inputs such as inorganic fertilizers, seeds and farm implements for use in the wetlands. Training is also provided on how to sustainably use this fragile resource. The study results show that 40.7% of households were enticed into wetland cultivation by NGOs' participation. Although the primary objective of

NGOs is to promote sustainable wetland cultivation, most elderly people indicated that NGO initiatives reduced the spectrum of goods and services obtained in the past. For instance, wild food directly harvested from wetlands is no longer available.

Households are also intensifying horticultural activities in wetlands due to the presence of external markets. This was confirmed by 30.9% of households using Chebvutembatemwa, Dufuya, Madigane and Tugwi wetlands. Wetland farmers either sold their produce to urban centres (such as City of Gweru and Zvishavane town) or newly resettled farming areas. Barter trading is also conducted between newly resettled farmers and horticultural farmers in wetlands. In Dufuya and Madigane, vegetables are exchanged for maize which is inadequately produced locally due to prevailing semi-arid conditions that constrict dryland crop farming. Therefore, external factors such as market dynamics influence demand of wetland resources. This was also observed in South Africa by Turpie (2010).

Change in human generation's beliefs also result in despising of socio-cultural values attached to wetlands, for instance, as sacred sites. All elderly people revealed that in the past, cultivation, grazing, washing of clothes and pots, inter alia, were prohibited activities; hence wetlands remained undisturbed and provided a wide range of goods and services. However, young people no longer see value in traditional beliefs as revealed by 85% of interviewed teenagers. For instance, some young people questioned the wisdom of preserving wetlands for rain-making ceremonies in light of modern weather forecasting and dissemination methods. In the process, some direct use values (e.g. wild fruits, medicine etc.) and indirect use values (e.g. flood control) are lost as young people are concerned with high turnover agricultural produce meant to improve their food security and generate income to fund their education.

2.3.3 Benefits derived from wetlands by communities

Benefits are realised through a broad spectrum of goods and services provided by the resource. However, the value attached to wetlands varied from wetland to wetland as shown by 'no response' in some cases (Table 2.6). Generally, the communities obtain provisioning and cultural services as classified under the Millennium Ecosystem Assessment. These include abstraction of water for brick moulding, drinking and washing; food in the form of vegetables, crops and fish for domestic use and sale; harvesting of thatch grass for domestic

use and commercial purposes; cutting of reeds for basket making mainly for sale; worms for fishing in the surrounding rivers and dams; collection of wild fruits and harvesting of traditional vegetables for household consumption; collection of fodder for rabbits kept for family consumption and income generation and extraction of honey from beehives installed in trees dotted around wetlands. Wetlands also have educational value, as researchers and students from various institutions of learning visit for academic excursions, a situation also observed in South Africa by Day and Malan (2010).

Four of the studied wetlands were mainly used for vegetables and/or crops. However, in the other two wetlands (Guruguru and Zungwi), these activities were much lower. This can be attributed to dry conditions existing in most parts of these wetlands which made vegetable and crop production difficult outside the rain season. Moreover, given the prevailing semi-arid conditions in the study area, wetlands were identified as a critical source of water for livestock of most households in Dufuya, Madigane and Tugwi. Generally, few households were obtaining natural products such as thatch grass, fish, wild fruits and traditional vegetables from wetlands. This can be attributed to the fact that most parts of the wetlands are under cultivation which altered the wetland conditions (Table 2.3).

Table 2.6: Percentage variations in households' responses on benefits obtained from wetlands, as measured by responses to a questionnaire survey

Goods/ Services	Madigane (n=28)	Dufuya (n=20)	Chebvute (n=25)	Tugwi (n=11)	Zungwi (n=22)	Guruguru (n=17)	Total (n=123)
Water	28.6	15	24	9.1	4.6	-	15.5
Vegetables	100	90	24	90.9	4.6	17.7	53.7
Crops	67.9	175	100	90.9	31.8	-	61.8
Pasture for livestock	3.6	25	12	18.2	4.6	5.9	10.6
Livestock watering	57.1	55	28	100	-	-	36.6
Thatch grass	7.1	-	4	-	4.6	11.8	5.6
Honey	-	10	12	-	-	-	4.1
Fish	-	10	-	18.2	4.6	-	4.1
Worms for fishing	-	-	12	-	-	-	2.4
Wild fruits	-	-	12	-	-	-	2.4
Reeds	-	-	8	-	-	-	1.6
Traditional vegetables	10.7	10	-	-	9.1	-	5.7
Sugarcane or Banana	14.3	15	20	18.2	-	-	11.4
Sacred sites	28.6	-	28	9.1	-	-	13
Education sites	-	10	4	-	-	5.9	3.3

Meanwhile, 51.2% of household respondents acknowledged that wetland benefits have been declining over the past three decades as wetland sizes and their characteristics were modified as shown in Table 2.3. Therefore the change and reduction in wetland ecosystem components such as vegetation and hydrology could have contributed to loss of direct benefits. In the case of Guruguru and Zungwi, few households are obtaining direct benefits since the wetlands have almost dried. Therefore, changes in wetland cover, especially vegetation, can be linked to reduction in the amount of benefits accessed by the local communities.

2.3.4 *Communities' level of dependence on wetland*

The results of the study show that 61.9% of household respondents revealed that wetlands are their major source of livelihood. The mean total income share derived from wetland resources is 48.2% and is comparably higher than findings by Thondlana et al (2012), where natural resources income accounts for 20% of total household income under desert conditions. In this study, mean total wetland income refers to the amount of income obtained from a wetland as a proportion of the total household income from diverse income sources. Nonetheless, Wilcoxon Signed Ranks Test results based on comparison of household income from wetlands and expected household expenditure shows that households' dependence on wetlands is generally high, but variations were noted between communities of wetlands studied as shown in Table 2.7.

Table 2.7: Comparison of households' estimated average annual income from wetlands and annual household expenditure

Wetland	Estimated mean annual income from wetland per household (US\$)	Estimated mean annual household expenditure (US\$)	Standard Deviation		Wilcoxon Signed Ranks Test 'p-values' at 95% Confidence Interval
			Wetland income	Household expenditure	
Dufuya	1443.20	1140.00	1752.75	1344.36	0.84
Madigane	717.43	959.14	1001.40	1469.45	0.10
Chebvute	181.96	510.48	406.50	653.04	0.00
Tugwi	831.27	603.63	1058.89	564.96	0.40
Zungwi	123.05	334.58	277.19	392.25	0.08
Guruguru	4.55	1160.90	21.32	1521.77	0.00
All sampled wetlands	527.13	815.33	1041.91	1177.73	0.00

In Dufuya, Madigane and Tugwi, households' dependence on wetlands is high compared to Chebputerambatemwa, Guruguru and Zungwi. Wetland income from Dufuya, Madigane and Tugwi contributed 95.1%, 64.3% and 97.2% respectively of household total annual income, an indicator that wetlands were a significant source of income, due to limited formal employment opportunities as shown by high number of unemployed household heads (91.9%), a situation also confirmed by Vitoria *et al.* (2012). Most of household income in Dufuya, Madigane and Tugwi is generated from sale of tomatoes and leafy vegetables with shorter growing period and high market turnover.

Although Chebputerambatemwa wetland is used for cultivation, farmers mainly grow cereal crops such as maize with a relatively longer growing period, and most of it is directly consumed since maize is a staple crop. Thus estimates from Chebputerambatemwa wetland could be under-representing the economic significance of the resource as households may be indirectly empowered financially by savings made from reduced purchase of food. In actual fact, wetland income contributed 0.01%, 35.5%, and 36.8% to total household annual income for Guruguru, Chebputerambatemwa and Zungwi respectively. In Guruguru income is very low as wetland farming is no longer practiced since cultivation in wetlands was abandoned when donor funding for BR/BF project was withdrawn. Today, the wetland is fallow and mainly used for livestock grazing. The other sources of income for the surveyed households were remittances (19.5%), piece jobs (79.7%), livestock (10.6%) and other natural resources, for instance, wood curving (5.7%).

On the other hand, the standard deviations show wide variations between income obtained from wetland and that which is used by each household at each study site (Table 2.7). This illustrates that income generated by households are widely different even from the same wetland. Therefore, careful consideration should be made when generalizing the economic significance of wetland and its bearing on people's conservation attitude. Spearman's Rank Order Correlation results show a statistically significant positive relationship ($r = 0.24$; $p = 0.01$) between period of wetland use and household income (Table 2.8). Households that have been using wetlands for a longer period (as the average is 9 years) had more income generated from strategically located, near sources of water, large portions of land acquired through consolidation of abandoned plots by resettled people.

Table 2.8: Relationship between households' socio-demographic background and wetland income

Variable	r – value	p – value
Period of using wetland	0.24	0.01
Distance travelled	-0.11	0.23
Estimated travel time	-0.11	0.21
Household size	-0.02	0.81
Age of household head	-0.07	0.47

Meanwhile, Spearman's Rank Order Correlation results show an insignificant negative relationship between household income and distance travelled to and fro wetland, estimated travel time, household size and age of household head. In fact, household income decreased with length of distance travelled (average 1 209 km), time spent travelling (average 23.39 minutes), increase in household size (average 5.9 persons) and advances on age of household head (average 41 years). The results however partly contradicts that of Svatwa et al (2008) who indicate that increase in household size was associated with more agricultural income due to abundance of labour. However, in the surveyed wetlands each family was allocated a small portion of land (mean 0.02 ha) to work on regardless of its size, a situation which renders the size of a household an inconsequential factor in determining extent of wetland use.

2.3.5 The effect of benefits from wetlands on people's conservation attitude

The continued existence of wetland including benefits obtained largely depends on people's attitude towards the resource which intrinsically influences existing management and conservation strategies. All interviewed elderly people, 85.4% households and 18.3% teenagers revealed that the primary reason wetlands should be protected is to safeguard the benefits from this fragile resource, especially those from cultivation. In Chebputerambatemwa, Dufuya, Madigane and Tugwi, wetland users were monitoring encroachment into preserved sections which are viewed as the primary sources of water. However, violations of local rules were not completely addressed as politicians sometimes sanction encroachment.

Chi-Square test results further show that the effect of wetland benefits on local people's attitude towards resource conservation do not vary with household head's level of education ($p = 0.22$), gender ($p = 0.07$) and marital status ($p = 0.14$), age ($p = 0.21$), distance of household location in relation to wetland ($p = 0.06$) and the number of years a family has

been utilizing the wetland ($p = 0.07$). Thus, regardless of age, gender, education, period of wetland use and distance travelled, most households managed wetlands in order to maintain use benefits. This result concurs with that of Mazambani and Dembetembe (2010) who revealed that local participation in natural resources management is enhanced when it is built on incentives.

During questionnaires administration, a woman said;

'Dai pasina dhewa iri, vana vangu vose vachingotenderera mumaraini vakashama. Mumunda muno ndimomunobva mari yavo yechikoro. Vose vari vatatu ishasha kugona muchikoro, zvokuti ndikabviswa muno hameno kuti ndovaita sei? Saka kuchengetedza dhewa, kuchengetedza upenyu hwemhuri yangu neramangwana ayo'

This can be translated to mean all my children's education, clothing and other basic requirements are sustained by the wetland, therefore people should be encouraged to use the wetland wisely as eviction from wetland use could spell doom to the future of her children. This suggests that local people should be given permission to use the wetland as the benefits obtained through goods and services are fundamental drivers to resource conservation.

The findings of the study demonstrate that people's dependence on wetlands is high, especially where they have not been degraded. It is also clear that most people are aware of the importance of wetland conservation in order to sustain direct use benefits which act as a conservation incentive. There has been no change in wetland utilization patterns as cultivation remains a predominant activity, alas at an increasing rate, and at the expense of wetland ecosystem integrity and other natural benefits. Increasing wetland cultivation is driven by declining dryland farming produce, market availability for horticultural produce and donor projects. Therefore, interventions that seek to promote sustainable cultivation should be sought to safeguard livelihoods and wetlands.

Therefore, the next chapter investigates the impact of cultivation on the biophysical conditions of wetlands of different hydrogeomorphic type. The other subsequent chapters will also examine the implications of existing institutional and policy frameworks governing access, use and management of wetlands given the observed indispensable high community dependence on the resource.

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CHAPTER THREE

THE ENVIRONMENTAL SUSTAINABILITY OF CULTIVATION SYSTEMS IN WETLANDS USING THE WET-HEALTH FRAMEWORK

3.1 Introduction

Wetlands are known to provide both direct and indirect benefits to societies, through both ecosystem goods and services (Millennium Ecosystems Assessment 2005). In areas highly dependent on natural resources, especially many parts of sub-Saharan Africa, direct use of wetlands for cultivation, grazing and aquaculture is widespread (Acres et al. 1985; Rebelo et al. 2010; Sakané et al. 2013). These activities are at the core of livelihood strategies of predominantly subsistence rural communities in these areas and as such are responsible for degradation of this precious natural resource (Whitlow 1989; Dahwa et al. 2013). In Zimbabwe for instance, an average wetland loss rate of 0.6% per annum was reported in Shurugwi district for the period from 1980 to 2003 (Madebwe and Madebwe 2005). This is evident in severe gully erosion and drainage (Ndhlovu 2009). Notwithstanding observations such as this, the reliance on wetland cultivation by subsistence farmers persists and in some cases, supported by non-governmental organizations (NGOs) under the auspices of wetland-based food security and poverty eradication programmes.

In order to conserve wetlands from increasing farming threats in Zimbabwe, a cultivation technique known locally as '*ngwarati cultivation*' was developed (Mharapara, 1995; 2000). In the Guruguru and Zungwi wetlands, this system of tillage using mechanised broad ridges and broad furrows (BR/BF) was implemented in 1999, under the Smallholder Dry Areas Resource Management Project, as a supposedly sustainable way of utilizing the wetlands without degrading them (Mharapara 1995; Mujaju et al. 2013). This literature, however, needs to be contrasted against the observations of Mbereko (2008), according to whom the introduction of the BR/BF project was an experiment to test the effectiveness of wetland conservation intertwined with increased agricultural productivity. The adoption of broad ridges and broad furrows tillage system has also been viewed as a way of rekindling a technique practised under shifting cultivation in the pre-colonial period (Whitlow 1985; Owen 1994), and was presumed to be sustainable (Chingwenya and Manatsa 2007). Since wetland degradation is generally more rapid than in other ecosystems (Ramsar Convention Secretariat 2010), it is important to assess the extent to which the BR/BF technique introduced, contributed to sustainable wetland utilization.

Crop and livestock production is promoted in the Dufuya wetland. NGOs such as Heifer International assisted local users to construct concrete canals to increase the extent of

irrigated land. Troughs were constructed for livestock watering since the wetland is situated in semi-arid conditions where water shortage is common in the dry season. Cattle fodder is also grown on the wetland. Although the agricultural production benefits of all the aforementioned NGO-initiated and implemented farming techniques are known (Mangoma 2011; Mujaju et al. 2013), little is understood about their effects on the biophysical status of the wetlands with which they are associated. To date, extensive research has been directed towards specific facets of wetlands, such as the hydrology, the vegetation, or the soils to name a few (Mazvimavi 1994; Dube and Chitiga 2011; Muzvondiwa et al. 2013). All these studies are segmented and do not give a complete representation of the wetland's holistic condition in light of the ever changing land uses due to climate variability, population pressure and other anthropogenic activities (Shoko et al. 2014). The evaluation of wetlands' overall condition is therefore critical since the degree of sensitivity to anthropogenic interventions is still largely unknown in most developing countries (Sakané et al. 2011). Understanding the interaction between wetland processes and land use is essential for effective wetland management, rehabilitation and restoration (Euliss et al. 2008; Mekiso et al. 2013).

In response to growing human modifications of wetlands and limited resources for ecological assessments, frameworks have been developed to expedite assessment of wetland ecological conditions (Warren 2005; Price et al. 2008; Macfarlane et al. 2009). An example of such frameworks is the WET-Health framework (Macfarlane et al. 2009) developed in South Africa and said to be applicable to southern Africa (Kotze, 2011) despite the existence of little evidence to substantiate this claim. Whilst the tools developed have great potential to assist in the planning of wetland management and rehabilitation, their application to wetlands in African countries is very limited. The WET-Health framework provides a set of indicators used to assess the extent of human impacts on three key interrelated components which define a wetland's ecological condition, namely hydrology, geomorphology and vegetation composition. Current studies in Zimbabwe treat these three wetland components as discrete entities (Mazvimavi, 1994; Dube and Chitiga, 2011; Muzvondiwa et al. 2013). Therefore, knowledge of wetland conditions in Zimbabwe is built on a partial view of reality; a situation that has been making effective wetland management difficult.

The assessment of agricultural practices in wetland using such tools is important, as some farming techniques have been observed to damage wetland ecosystems more than others (van Dam et al. 2014). Moreover, in light of increasing donor funded programmes in wetlands aimed at reducing rural poverty, it is prudent to understand how exogenous practices unlike endogenous (given history of traditional sustainable use of wetlands) modify wetland conditions since factors affecting the vulnerability of individual wetlands in Zimbabwe are poorly understood, yet rural poverty relief programmes of this nature may proverbially speaking be ‘killing the goose that lays the golden egg’ due to their acceleration of wetland degradation, and in the process undermining the tenets of sustainable land management as revealed by Liniger et al. (2011). The specific focus of this paper is to present a comprehensive assessment of cultivated wetland conditions in rural Zimbabwe in relation to current farming methods. In this study, a WET-Health framework (Macfarlane et al. 2008) was used to describe the biophysical status of cultivated wetlands under different farming techniques.

The WET-Health method is a tool designed to assess the health of a wetland by evaluating the impact of land uses on the ecological condition of a wetland. The assessment of the current state of the three components (hydrology, geomorphology and vegetation) is based on the impact and indicator scores of the effect of human activities on a specific wetland. The method accounts for the effects of land use in both the catchment and the wetland (by separately assessing the condition of the two areas) given the link between a wetland and its catchment area. Using a combination of threat or vulnerability, the method also account for the likely trajectory of change in the wetland. The overall health of the wetland is presented by combining the scores of present state and likely trajectory of change. This approach therefore does not only provide an indication of wetland health but also highlights the key causes of wetland degradation.

3.2 Materials and methods

3.2.1 Field methods

The assessment of the biophysical condition of wetlands was guided by Level 2 of the WET-Health framework (Macfarlane et al. 2009). Unlike level 1 assessment which is largely based on desktop evaluation, level 2 involves field evaluation based on planned sampling and data

collection. A field assessment was conducted during the dry summer season, between 21 September and 17 October 2013, a time of the year when cultivation and other water related activities are actively supported by the presence of water/moisture in the wetland. Each wetland's hydrogeomorphic (HGM) type(s) was identified and described basing on geomorphic setting (e.g. hill-slope, channelled valley bottom or unchannelled valley bottom; whether the drainage is open or closed), water source (whether it is surface or subsurface or both) and pattern of water flow through the wetland unit (whether it is diffused or channelled) (Macfarlane et al. 2008; Kotze et al. 2012).

Soil texture and natural level of wetness were determined during the field survey. The estimation of soil texture was based on a 'finger test' (Kotze 2011; Macfarlane et al. 2008), and to maintain consistence, samples from different HGM units were assessed by the same experienced field researcher. Three soil profiles, 1.2 m deep were used to estimate the degree of soil wetness per HGM unit, based on soil water regime classes (Kotze et al. 1996; Kotze et al. 2000).

Semi-structured interviews were conducted with local wetland users during the field survey in order to gather information on the possible effects of land uses on wetland biophysical conditions as well as projected future use. In the Dufuya wetland, eleven farmers working their plots during the survey were interviewed. In a bid to include farmers in different locations of the wetland, purposive selection was done. In Guruguru and Zungwi wetlands, at least five former users (since wetland cultivation was recently abandoned) were selected for interviews using a snowball sampling technique, to understand land use trends. In addition, two elderly persons were also selected for each wetland through snowball sampling technique to tap their institutional memory on patterns of wetland use and changes in their biophysical conditions.

3.2.2 Wetland delineation and land-cover mapping

The areas of major land transformation within the wetland and the upstream catchment were mapped, and all features (e.g. artificial drains and their characteristics - density, depth, location and obstructions; gullies, presence of vegetation. etc) with potential to influence the biophysical condition of the wetland were observed and described. High spatial resolution RapidEye Spaceborne imagery which permits detection of fine scale features such as

wetlands was used to map the major land cover/land use (LCLU) types in the three wetlands sites.

The RapidEye image comprises of five unique spectral bands; namely blue (440 – 510 nm), green (520 – 590 nm), red (630 – 685 nm), red-edge (690 – 730 nm) and, near-infrared (760 – 850 nm) with a 4 m spatial resolution. The satellite images selected for this study were acquired on days with clear sunny skies, enabling precise detection of wetlands (The images were acquired on the 29th of September 2013 for Dufuya and 30th of September 2013 for Zungwi and Guruguru wetlands). The RapidEye images were obtained in a 3A format (i.e. atmospheric, geometric, and radiometric corrections already applied to the datasets). Atmospheric correction removes any atmospheric distortions such as those caused by cloud cover so that images are clearly analysed. Geometric correction assists to assign real surface coordinates (map) to the images for accurate analysis. Radiometric correction helps to obtain the real irradiance or reflectance of the image by correcting spectral distortions caused by the sun angle, sensor, and topography among other factors.

The corrected RapidEye imagery was classified using the supervised classification method, maximum likelihood function. The classification model was trained using a training of 86 sample points and 42 test sample points, and a kappa statistic of 0.73 was obtained. Kappa statistic is a procedure to assess the accuracy of a classification based on comparison of reference data (ground truth) to classified map. Also, the extent of the land use types generated through RapidEye imagery was verified through the high resolution Google Earth image and field observations during ground truthing. The boundaries of the three wetlands and portions covered by BR/BF were digitized from the 2013 Google Earth image, validated by ground truthing from walk in field mapping using a GPS receiver, Garmin GPS 60; and these were finally used as training sites to map wetland areas on remotely sensed images.

3.2.3 Acquisition of local climate and slope data

Local climate data namely; mean annual precipitation (MAP) and potential evapotranspiration (PET) was used to assess the effects of local climate on wetland hydrology (degree of wetness and water availability) and geomorphic processes (such as erosion and deposition). Using this dataset, the MAP-PET ratio (which defines the aridity index of an area) was calculated (Maliva and Missimer 2012). The ratio was used to score the

contribution of climate to amplifying or dampening the effects of flow-reducing activities in the HGM unit's catchment. MAP data was obtained from the Meteorological Services Department of Zimbabwe (MSDZ) for the period between 1979 and 2013. The weather stations were located in the three districts. PET data was obtained from New_LocClim 1.10, a local climate estimator software program and database developed by FAO, accessed on 21 September 2013 via: <http://www.fao.org/nr/climpag.asp>. Slope was determined using a 1:50 000 topographic map with ground truthing, since it influences hydrological and geomorphological process in the wetland and its vicinity.

3.2.4 Assessment of wetland ecological condition

The ecological condition of the wetlands was assessed by examining how LCLU activities in the wetlands and their catchments affected the wetland hydrology, geomorphology and vegetation composition, using the WET-Health framework (Table 3.9).

Table 3.9: Assessment criteria of the ecological conditions of the wetland

Component	Description
Hydrology	This can be altered through (i) changes in water inputs as a result of human activities in the catchment upstream of the wetland or (ii) modifications within the wetland that can alter the water distribution and retention patterns within the wetland and (iii) increase evapotranspiration.
Geomorphology	This is defined as the distribution and retention patterns of sediment within the wetland, and focuses on evaluating changes in both (i) depositional and (ii) erosional patterns within the wetland as a result of human activities.
Vegetation	This includes the extent of total removal of the indigenous vegetation and its replacement as well as the extent to which the composition of areas of natural or semi-natural vegetation has been altered through an increase in the abundance of ruderal (weedy) or invasive plants.

Adapted from Kotze (2011) after Macfarlane et al. (2008)

The ecological condition of the wetland was determined by separately assessing the spatial extent, intensity and magnitude of human modifications based on pre-determined indicators that are rated using scores from the WET-Health framework (Macfarlane et al. 2008). The spatial extent refers to the proportion of the wetland and/or its catchment affected by a given activity and was estimated and expressed as a percentage of the whole area. The intensity which refers to the degree to which wetland characteristics have been altered within the affected area was measured on a scale of 0 (no impact) to 10 (complete transformation).

Extent and intensity were then combined (by multiplying extent and intensity) to determine an overall magnitude of departure from the natural reference point (Kotze et al. 2012). The results of the three assessments (hydrology, geomorphology and vegetation) for each HGM unit were then aggregated into an overall score of the wetland evaluated, reflecting the present state of wetland health.

The composite health score falls within a range of 0 (unaltered wetland) to 10 (critically altered wetland). The composite score (on a scale 0 – 10) is translated into one of the six health classes on an impact scale of 1 - 6 or health category A – F. The ecological classes are as follows: A, 0 – 0.9 (natural); B, 1 – 1.9 (largely natural); C, 2 – 3.9 (moderately modified); D, 4 – 5.9 (largely modified); E, 6 – 7.9 (extensively modified); and F, 8 – 10 (critically modified) (Macfarlane et al. 2008; Kotze et al. 2012). The likely trajectory of change for each wetland was determined by identifying potential threats to wetland ecological health. Trajectory of change was determined qualitatively based on application of the tool (following Macfarlane et al. 2008) and interviews with local users.

3.3 Results and discussion

3.3.1 Observed hydrogeomorphic types of wetland

Dufuya wetland resembles a channelled valley bottom HGM type, which is found at the headwaters of a first order stream which flows into Somkamba stream (second order). The wetland's principal source of water is sub-surface flow. Given the prevalence of Kalahari sands on a gentle slope characterised by a bush land (composed of shrubs and grass) and cultivated area with contour ridges, infiltration of the upstream catchment area of Dufuya is possibly high resulting in very little natural surface run-off. There is a stream traversing the Dufuya wetland and is continuously fed by a spring found upstream of the wetland. The presence of loam soils, with moderate hydraulic conductivity (Macfarlane et al. 2008); also allow sub-surface water to spread across the wetland. The dominance of sub-surface inflows into the wetland explains why wet conditions persist throughout the year. According to Acres et al. (1985) the amount of groundwater into the wetland depends on the size of the catchment and interfluvial width. Generally, for wetlands relying on underground water, small wetlands with large catchment receive more sub-surface inflows. This would appear to apply

to Dufuya with a huge wetland-catchment ratio (Table 3.2), where the wetland size is only 4.2% of its catchment size.

Table 3.10: Wetland size, vulnerability to local climate and slope angle

Wetland Name	Wetland size (ha)	Wetland catchment size (ha)	Mean slope angle (%)	MAP (mm)	PET (mm)	MAP:PET ratio	Vulnerability factor ^a
Dufuya	24.2	572.1	3.8	682	1573.9	0.45	1.0
Guruguru	13.4	38.4	2	840.3	1573.9	0.53	0.95
Zungwi	26.6	58	1.7	537.9	1778.7	0.30	1.05

^aThe vulnerability factor is used as a multiplier in the calculation of impact intensity of land uses in the catchment that reduce flow (e.g. eucalyptus plantation). The vulnerability factor for each wetland was determined using a calculated score for MAP:PET ratio applied on a predetermined vulnerability scores scale in MacFarlane et al. (2008).

Where the vulnerability factor is <1, it decreases the intensity score, but where >1 it increases the intensity score.

Guruguru and Zungwi wetlands broadly resemble features of an unchannelled valley bottom wetland. The two wetlands have gentle, longitudinal slopes (Table 3.2) and no clearly defined streams. Both lie at the head of Gweganomombe and Satura streams respectively, which are first order streams. The predominant source of water for Guruguru is direct precipitation as shown by MAP:PET ratio (Table 3.2) and to a lesser extent sub-surface flow influenced by infiltration of gentle terrain dominated by sand soil derived from granite rock underneath. The Guruguru wetland is located near the head of a watershed, a situation likely to limit sub-surface water yield as flow is most likely to take different directions. The Zungwi wetland is sandwiched between mountains. The surrounding steep slopes dominated by vegetation contribute to both surface run-off and infiltration and hence sub-surface inflows. However, there is little evidence of seepage at the foot of the slopes. Therefore, surface run-off is the primary source of inflows although the contribution of sub-surface flow is possible. In summary, all wetlands are a single HGM unit type, although there are internal variations in terms of the sources of water, mean slope angle, soil types and infiltration.

3.3.2 An assessment of the ecological state of the wetlands

3.3.2.1 Hydrology component

The hydrology of each wetland is assessed in relation to the impact of upstream catchment LCLU type on the quantity and pattern of water inputs to the wetland as well as the impact of on-site activities on water distribution and retention within the wetland itself. The images

were classified into seven major land cover classes namely; bare land, grassland, plantation, water, sparse vegetation, dense vegetation and cultivation (Figure 3.1) to determine the spatial extent of LCLU.

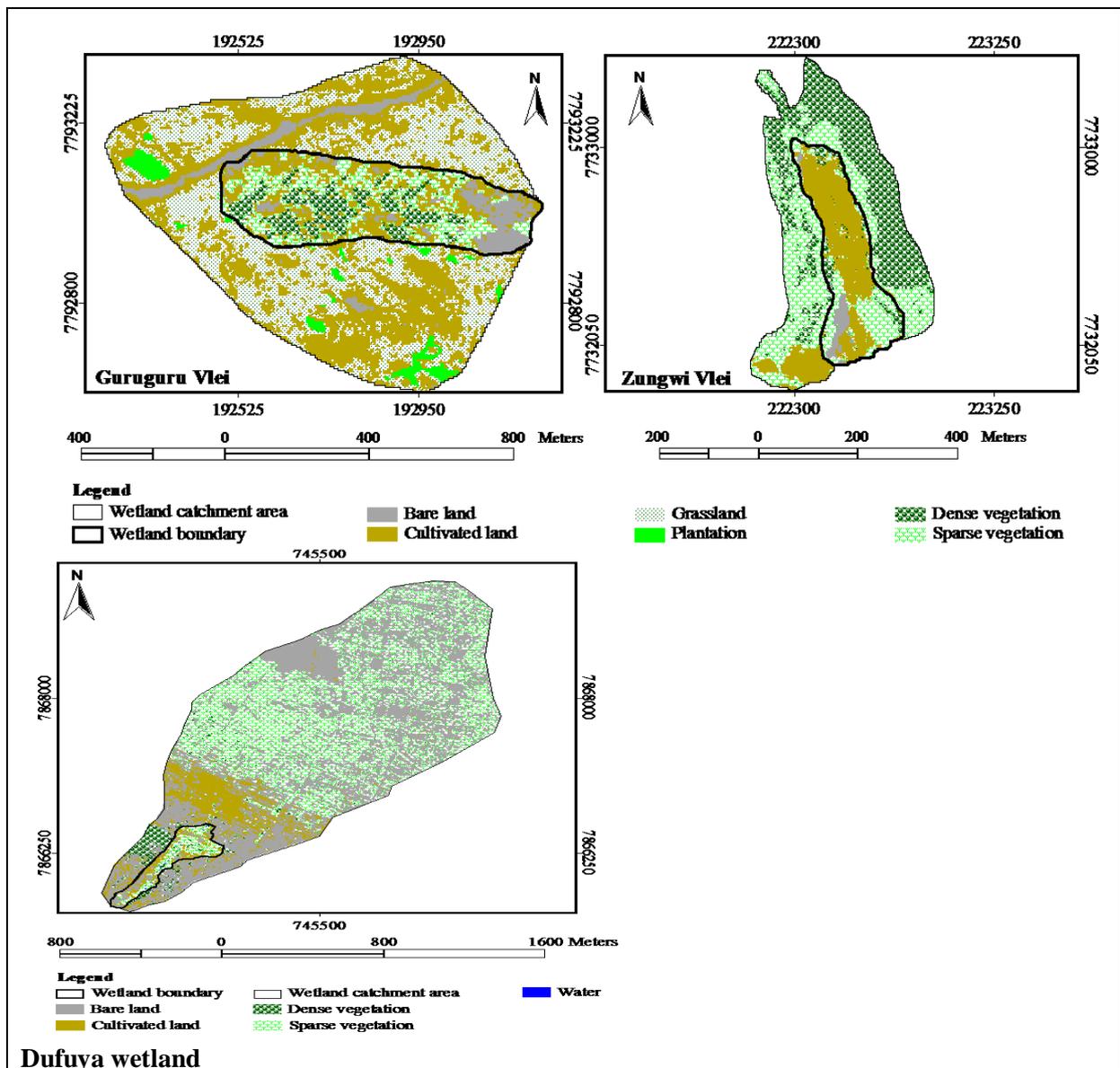


Figure 3.1: Classification maps of Dufuya, Guruguru and Zungwi wetlands and their upstream catchments

Results in Figure 3.2 shows that the upstream catchment of Zungwi is dominated by bush land, conditions most unlikely to reduce natural inflow quantities into the wetland as it is dominated by sub-surface inflows. A large section of Dufuya catchment (48.6%) is covered by bare area naturally associated with lower infiltration, greater surface run-off and increased flood peaks (Zhang and Schilling 2005). The bare conditions were influenced by abandoned farms and livestock grazing. However, the presence of sandy soils on a gentle gradient and

well oriented contour ridges in cultivated fields potentially increase infiltration on bare area, thereby resulting in only a small increase in surface run-off as shown in Table 3.11, which may not necessarily result in discernible reduction of sub-surface water inputs.

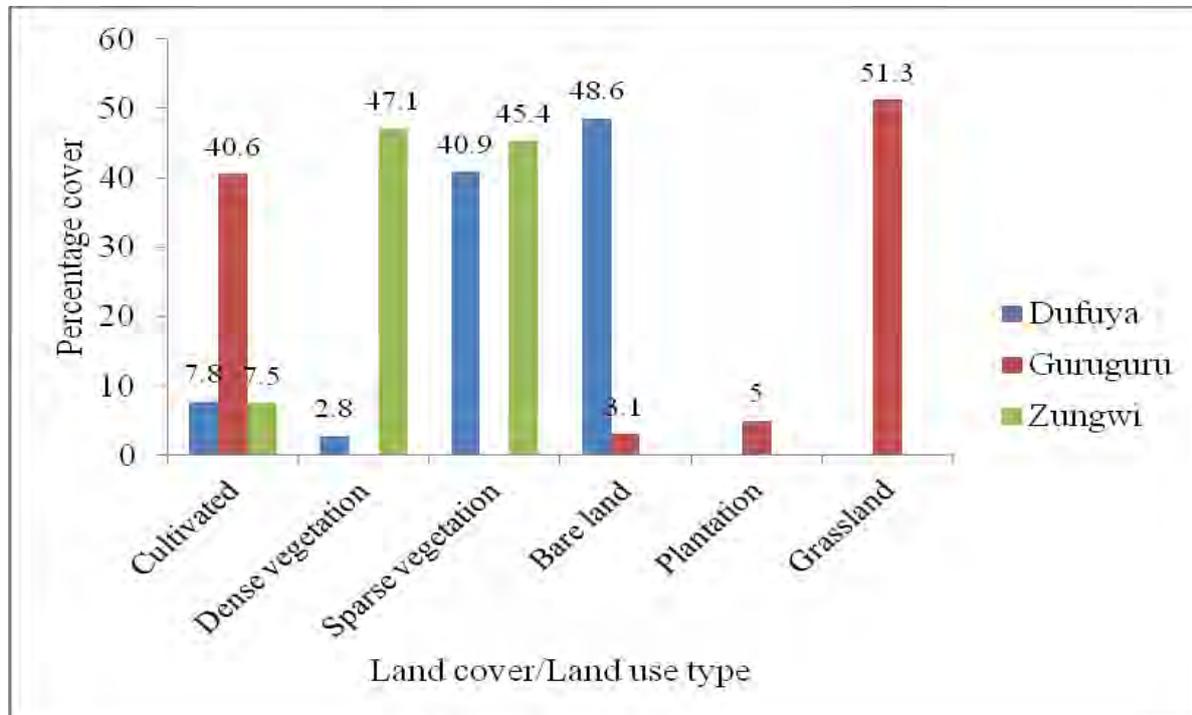


Figure 3.2: Proportion of land cover/land use coverage in the upstream catchment areas of wetlands

The upstream catchment of Guruguru is mainly characterised by grassland with scattered shrubs in abandoned fields, cultivated area and a eucalyptus plantation in the non-riparian area covering 5% (Figure 3.2). Although eucalyptus trees are generally known for high water demand and hence abstraction (Jagger and Pender 2000; Morris et al. 2004; Joshi & Palanisami 2011), their spatial extent and location in Guruguru suggests that its net effect on inflow quantities is negligible as shown by a score of -0.29 on Table 2.3. This score indicates that the overall impact of plantation and other LCLU in the upstream catchment on water input to the wetland is negligible. Moreover, grasslands and cultivated fields with soil conservation contour ridges intercept surface run-off and enhance soil infiltration in Guruguru’s upstream catchment. Although dominance of vegetated landscape upstream of Zungwi influences infiltration, surface flow remains dominant due to influence of steep slopes in the mountainous catchment area.

Table 3.11: The impact of upstream catchment activities on wetland hydrology

Wetland name	Magnitude of impact scores ^a			
	Impact of land use activities that reduce the inflow (surface & sub-surface) quantity to the wetland		The intensity of impact of factors potentially altering flow patterns to the wetland	
	Score	Description	Score	Description
Dufuya	0	Negligible	2	Small increase
Guruguru	-0.29	Negligible	0	No effect
Zungwi	0	Negligible	0	No effect

^aMagnitude of impact scores range: 0 – 0.9 (no effect/negligible); 1 – 1.9 (small); 2 – 3.9 (moderate); 4 – 5.9 (large); 6 – 7.9 (serious); 8 – 10 (critical). The reasons behind the scores are explained in accompanying text.

There is little presence of hardened surface and bare land in Guruguru and Zungwi catchments; meaning no substantial increase in flood peaks is expected. Settlements associated with surface crusting and compaction that generate more surface run-off are absent in catchments of Guruguru and Zungwi and very few are found in Dufuya covering less than one percent of the mapped upstream catchment. Overall, land use types in upstream catchments do not have visible impact on the quantity and pattern of inflows, except in Dufuya where a small increase on surface run-off is likely attributed to the existence of a large bare area in its catchment.

Dufuya has concrete canals, about 30 cm deep and 50 cm wide, covering about 30% of the wetland area, established to distribute water to wetland fringes in the lower sections during the dry season. These canals inhibit diffusion of water within the wetland (Galbraith et al. 2005), a situation confirmed by local users who observed desiccation in affected areas which used to be perennially wet. The stream traversing Dufuya is not modified and is dominated by vegetation like *Kyllinga erecta* and *Fimbristylis dichotoma* species, which grow and colonize rapidly under wet conditions (Dube and Chitiga 2011). The presence of dense vegetation in the stream increase surface roughness which slows the rate of flow by offering high resistance (Lau and Afshar 2013); hence more water is retained in the wetland. Therefore, removal of concrete canals inhibiting diffusion of water within the wetland may result in enhanced water diffusion resulting in expansion of the wetland conditions, whereas removal of hydrophytes through land clearance for cultivation and hydrological alteration may mean shrinking of the wetland as reduced surface roughness enhance loss of water through surface run-off.

Loamy soils with a moderate hydraulic conductivity on the other hand, facilitate a relative ease of distribution of sub-surface water in Dufuya. Sugarcane covers 0.02 ha, which is less than one percent of the entire wetland. A shallow well drilled near the spring on the upper section of Dufuya wetland, for domestic use, is abstracted using buckets all year round. However, the effect of sugarcane plantation and domestic water abstraction on water distribution and retention in the wetland is rated as low. Although the magnitude of impact of on-site activities with a score of 2.7 is rated overall as moderate in Dufuya mainly due to the effect canals (Table 3.4), evidence confirmed by elderly people shows that the wetland is expanding in areas unaffected by canalisation.

Table 3.12: The magnitude of impact of different land uses on the present hydrological state and the expected trajectory of change in the three wetlands

Attribute	Magnitude of impact score ^a					
	Dufuya		Guruguru		Zungwi	
	Score	Description	Score	Description	Score	Description
Water inputs	1.5	None	0	None	0	None
Water distribution and retention	2.7	Moderate	10	Critical	1.9	Small
Present hydrological state ^b	3.5	Moderate	8.5	Critical	1	Small
Trajectory of change	0	(→)	0	(→)	-1	(↓)
Overall hydrological state ^c	C (→)		F (→)		B (↓)	

^aMagnitude of impact scores range: 0 – 0.9 (no effect/negligible); 1 – 1.9 (small); 2 – 3.9 (moderate); 4 – 5.9 (large); 6 – 7.9 (serious); 8 – 10 (critical).

^bPresent hydrological state is determined by combining (using a matrix with colour codes corresponding to the impact categories – details in Macfarlane et al 2009) score of magnitude of impact of altered quantity and pattern of inputs and impacts of on-site activities on water distribution and retention patterns in the wetland.

^cThe overall hydrological impact score shows the degree of wetland integrity modification and is determined by combining present hydrological state and trajectory of change scores.

The arrow symbols show the likely direction of change of the wetland's hydrological condition, determined based on change score ranging from 2 (substantial improvement) to -2 (substantial deterioration).

The entire Guruguru wetland and 21.6% of Zungwi are covered by abandoned ridges and furrows. The broad ridges and broad furrows are approximately 3 m wide. The ridges are 60cm high so that they can hold water to a level of 30cm high in the above furrow. The use of cut and fill method (Mujaju et al. 2013) to construct ridges and furrows resulted in complete destruction of wetland vegetation (thereby reducing surface roughness critical for water retention) and modification of soil structure as top soil was buried. A master ridge was constructed upstream of the Guruguru and Zungwi wetlands to intercept flow from the catchment area, and excess water (that is water which cannot be contained by the furrow and eventually flows into the next furrow) is subsequently released in a feeder system to lower drains. This means water retention and distribution in the wetlands have been disrupted by

interception which delays release of water downstream, especially in HGM units like Zungwi which predominantly rely on surface run-off.

The depth and high density of drains in Guruguru and Zungwi mean some intercepted sub-surface and surface water is exposed to evapotranspiration due to high PET (Table 2.2) and possibly actual evapotranspiration. The orientation of furrows and ridges (facing down slope) led to flooding of non-wetland fields adjacent to Zungwi wetland; an uncommon phenomenon prior to the establishment of BR/BF as indicated by local people. Moreover, responses from interviewed elderly people in the area indicated that wetland drainage has resulted in the reduction of sub-surface water-level as evident in a deep well located a few metres down slope of Zungwi wetland margin, which used to provide potable water, all year round, to local residence and beyond even during drought years. Probable causative factors are, BR/BF channel water away from the wetlands, disrupting the normal hydrological processes (both surface and sub-surface flows) critical to maintenance of biophysical process and vegetation patterns in wetlands.

Contrary to the conception that BR/BF assist in sustainable use of communal wetlands (Mangoma, 2011), this cultivation technique actually contributes to desiccation through drainage, encouraged retention resulting in flooding of adjacent arable land, intercepting flows and increasing evaporation surface. BR/BF also disrupted the naturally established hydrological wetland processes by redistributing water to non-wetland areas. The significant contribution of drains to wetland drying is also well studied (Dixon 2002; Integrated Water Management Institute (IWMI) 2014). The hydrological impact of BR/BF was more evident in Guruguru where it is rated as critical since the entire wetland was drained than in Zungwi where it is rated as small since only a quarter of the whole wetland area was converted (Table 3.4).

Since Guruguru and Zungwi wetlands have fairly gentle terrains (Table 3.2), some of the water is likely to be concentrated in furrows. However, due to the presence of loamy sand and sandy loam soils in Guruguru and Zungwi respectively, with moderate to high hydraulic conductivity (Macfarlane et al. 2008), more water may be lost to seepage out of these wetlands, as suggested by Houser (2003) who observed that a soil's particle size distribution has a larger impact on its hydraulic properties. A small dam was constructed downstream of

both wetlands (at the outlet) to impound excess water from draining away. This has affected free draining of water, resulting in the subsequent inundation of colonizing vegetation. The absence of spillways on dams in the Guruguru and Zungwi wetlands further increases the likelihood of gully formation in the event of bursting and/or overtopping. Gully formation can be accelerated by the high erodibility of the prevalent sand soils, with an erodibility rating value of four (Stocking 1984). High erodibility of sand soils is also confirmed by research which applied the Universal Soil Loss Equation (USLE) (Manyiwa and Dikinya 2013; Imani et al. 2014) and Soil Loss Equation for Southern Africa (Munodawafa 2012) in semi-arid environments. Gullying may therefore contribute to further drying of wetlands (Acres et al. 1985; Ellery et al. 2009).

The present hydrological state of Dufuya is likely to be maintained as construction of more concrete canals was banned and strict regulations prohibiting extension of gardens and the further encroachment into pristine areas are enforced. In contrast, local people in Zungwi want to restore cultivation on BR/BF if they get funds to fence the wetland and buy agricultural inputs since wetland cultivation on loamy sand soil demands high application of fertilizers due to poor soil nutrient content as a result of nutrient erosion caused by water runoff from the top of the ridges to the furrows and alteration of soil structure as ridges were constructed from sub-soil formed from granite rock (Mujaju et al. 2013), which local people cannot currently afford. Resuscitation of cultivation may further depreciate the wetland's hydrological integrity as invading vegetation will be cleared to pave way for crop production; thereby reducing surface roughness and internal cohesion. Lack of prospects to restore the Guruguru wetland may result in its critical hydrological condition remaining largely unchanged.

In summary, the three wetlands' present hydrological conditions are mainly affected by on-site activities rather than land use activities in upstream catchments and future conditions are likely to remain unchanged in Dufuya and Guruguru, or may slightly decline in Zungwi (Table 2.4). Results of this study therefore contradict those of Mharapara (1995) that wetland hydrological conditions are mainly affected by catchment activities in Zimbabwe. Whilst conservation of upstream catchments of wetlands is critical, the results of the study show that more conservation attention should be focused within the wetlands.

3.3.2.2 Geomorphology component

Soil conservation measures such as contour ridges to reduce erosion have been effective in trapping sediments in cultivated sections of upstream catchments of the three wetlands. In Dufuya wetland, there is a small bridge (approximately 10 m) connected to a gravel road stretching for approximately 700 m along the northern fringe of the wetland. The same road passes through the wetland in the north-western corner. The earthen filling (gravel and stones used to construct the road and fill sides of the bridge) is likely to disrupt normal erosion and deposition in about 13% (approximately 3 ha) of the wetland area. Erosion in the wetland is likely to be initiated from culverts established to divert run-off from the road. However, there was no evidence of 'fresh' sediment planes in the wetland during field surveys. At the same time, the wetland's expansion is inhibited by the compacted gravel road as evident in wetland expansion eastwards rather than northwards where it ends on the margin of the road. Therefore, the effect of road construction on hydrological and geomorphological processes is apparent in Dufuya where natural wetland expansion is confined by a gravel road. This result concurs with that of Rivers-Moore and Cowden (2012) whose model predicted that wetlands located close to main roads are more likely to be degraded than those away from such infrastructure.

A gully (mean depth approximately 1.5 m, mean width approximately 3 m) is eroding in the upper section of Dufuya wetland near the spring which is the major source of water inflow. The advancing headcut threatens the existence of the wetland as it may result in drainage and drying. The eroded sediment is entirely deposited in the wetland although there is very little evidence of depositional features. Thus, the rate of vegetation growth is able to colonize and stabilize the influx of sediment at present. The bed and sides of the gully are almost devoid of vegetation, due to livestock grazing and trampling as the gully is located close to a constructed trough for livestock watering, a situation which can accelerate erosion in the event of a storm given expected small increase in surface flows from upstream catchment as explained under the hydrology component. Erosion emanating from tillage is very limited in Dufuya wetland as farmers use hand tools such as hoes and conservation farming techniques such as minimum tillage, manure, mulching and crop rotation. Vegetation was left at plot boundaries as a measure to minimize erosion on the fairly gentle terrain. In summary, the Dufuya geomorphic processes have been moderately modified by road construction and an upstream headcut although the system remains largely intact.

On the other hand, the geomorphology of Guruguru and Zungwi is largely unmodified due to the presence of vegetation on the upstream catchments (Figure 3.2) and the adoption of soil conservation measures in cultivated areas which reduce natural surface run-off. Like the Dufuya wetland, there are no identifiable erosional and depositional features. There was no tilling in Guruguru over the last 10 years and in 20% of Zungwi section previously under BR/BF. Therefore, there is limited erosion in fallow areas due to presence of colonizing vegetation.

Wetlands' vulnerability and trajectory of change due to erosion was assessed by establishing the relationship between wetland longitudinal slope and wetland size which was used as a proxy for discharge (Ellery et al. 2009). The gully in Dufuya is likely to extend due to the wetland's steep gradient in relation to its size (Table 3.2), slight increase in surface run-off as a result of extended bare area (due to overgrazing in catchment area as livestock herd per household has been increasing, e.g. by 66.7% between 1990 and 2013 [Marambanyika and Beckedahl in review]) and cattle trampling due to the proximity of the gully to a cattle watering point. It has been observed that cattle trampling can contribute to soil loosening with potential to accelerate headcut erosion on the steeper gradient. The contribution of livestock trampling to soil erosion is well studied (Dahwa et al. 2013; Morris and Reich 2013).

Although the gradient is steep for Guruguru wetland's size (Table 3.2), the absence of erosional features (e.g. gullies) and the unlikely change of current catchment and wetland cover may result in no natural changes on the geomorphic state of the wetland in future. In Zungwi, the absence of gullies and presence of a gentle slope for a wetland of this size (Table 3.2) suggest that minimal natural erosion will take place, although prospects of resuming cultivation as indicated by the local people may result in deterioration of the geomorphological health if no proper management practices are put in place to mitigate erosion. However, the likelihood exists that gully erosion may occur in both Guruguru and Zungwi in the event of dam bursting and/or overtopping.

3.3.2.3 Vegetation component

Vegetation in the three wetlands has been substantially modified by the activities of cultivation, draining, damming and the invasion of alien species (Table 3.5); hence all the wetlands fall under the ‘E’ category (Macfarlane et al. 2009). This category represents a situation where vegetation is significantly altered but some characteristic native species remain, although the vegetation consists mainly of introduced, alien and/or ruderal species. In the Dufuya and Guruguru wetlands, vegetation has been lost mainly to cultivation and BR/BF covering almost seventy percent of each wetland’s total area (Table 3.5). About two thirds of Dufuya is currently under tomatoes, onions, maize and other vegetables. Cultivation is done throughout the year, resulting in active maintenance of fields or gardens; hence the removal of most indigenous vegetation, mainly grass and weeds. Concrete canals are contributing to permanent loss of hydric species in Dufuya as well as the reduction of hydrophytes in some sections in the south-eastern part of the wetland.

Table 3.13: Estimated magnitude of impact in each vegetation disturbance class based on extent and intensity

Disturbance class	Disturbance class extent (%) ^a			Intensity score ^b			Magnitude of impact ^c		
	Dufuya	Guruguru	Zungwi	Dufuya	Guruguru	Zungwi	Dufuya	Guruguru	Zungwi
Ridge and furrow	-	99.5	21.6	-	7	7	-	6.97	1.51
Cultivated	68.2	-	70	10	-	8	6.82	-	5.60
Natural	31.2	-	8.4	1	-	2	0.31	-	0.17
Dam	-	0.5	0.1	-	5	6	-	0.03	0.01
Canals	0.6	-	-	10	-	-	0.06		
Overall weighted impact score							7.19	7	7.29

^aExtent is the estimated area covered by each disturbance, expressed as a percentage

^bIntensity is the expected change/rate of change, whereby it ranges from 0 (no loss/entirely natural vegetation exists) to 10 (critical or total loss of wetland vegetation).

^cMagnitude of impact score range for vegetation condition: 0–0.9 (none), 1–1.9 (small), 2–3.9 (moderate), 4–5.9 (large), 6–7.9 (serious), 8–10 (critical).

Largely intact patches of natural wetland vegetation mainly composed of *Andropogon ecucomus*, *Kyllinga erecta* and *Fimbristylis dichotoma* species are found around the spring at the headwaters of Dufuya, along the stream, in a few fallow areas and on plot boundaries. The area surrounding the spring is fenced; hence a thicket is present due to limited disturbance by human activities. Meanwhile, local people indicated that vegetation along the stream is maintained due to effective monitoring and the prohibition of agricultural encroachment by wetland users. This is monitored and enforced by traditional leaders and government agencies like the Environmental Management Agency.

Guruguru and Zungwi vegetation was lost to clearing and draining during construction of abandoned mechanised BR/BF. The whole area of Guruguru is under ridges and furrows as well as approximately twenty percent of Zungwi wetland (Table 3.5). In Zungwi, elderly interviewees indicated that wetland tree species like *Syzygium guineense*, known to thrive in wetlands of moderate rainfall (Drummond 1981), was completely lost. Guruguru wetland was previously dominated by *Schizachyrium jeffreysii* and *Kyllinga erecta* grass species. The drained area has been colonized by grass species like *Perotis patens*, *Pogonarthria squarrosa* and *Triraphis schinzii*, commonly found in disturbed areas of drylands with sand soils (Lightfoot 1998). The presence of non-wetland vegetation shows that the rate of hydric species recovery is poor due to disrupted hydrological processes mainly by drains that commonly dry out wetlands (IWMI 2014), thereby reducing the likelihood of wetland species persisting.

In Dufuya, no changes are expected on the status of vegetation as most of the current land uses have been sustained for over a decade as a result of strict monitoring of conservation practices, although increased community reliance on wetland cannot be ruled out due to increasing climatic variability (Mazvimavi 2010). The other problem may be a slight increase in sediment yield as a result of increased flows and erosion due to overgrazing in the catchment area as average livestock herd per household has been increasing (e.g. 66.7% increase in cattle between 1990 and 2013). In the event of this happening, catchment sediment yield and wetland deposition may alter vegetation composition (Cavalcanti and Lockaby 2006).

The overall extent of vegetation modification in Dufuya will depend on existing intervention measures. For instance, the government of Zimbabwe has been encouraging communal farmers to destock in response to declining pasture size and quality as a result of reduction in rainfall amounts. Alien invasive species like *lantana camara* and ruderal species such as *eragrostis heteromera* and *eragrostis cylindriflora* have been identified mainly on the fringes of the wetland. Invasive species are known to modify all major ecosystem processes; hence some native biodiversity may be lost (Raizada 2007). Changes in vegetation may negatively affect hydrology given the integrated nature of these two wetland components. This likely

outcome is conditional as local people have been mobilised to routinely clear the invasive species.

Plans to resume cultivation on ridges and furrows in Zungwi are likely to deter natural vegetation recovery resulting in the potential total loss of wetland species. On the other hand, recovery of wetland species in Guruguru is likely to be slow due to absence of wetland rehabilitation and continuation of grazing of livestock. Overall, the current substantially altered vegetation composition is expected to deteriorate to critical levels in Zungwi if cultivation on BR/BF is resumed whereas no significant changes are expected in Dufuya and Guruguru as changes in LCLU is unlikely.

3.3.2.4 Overall ecological condition of the wetlands

As highlighted in Table 3.6, wetlands are vulnerable to land uses in different ways. This was also confirmed by a number of studies (e.g. Winter et al. 2001; Kotze, 2011). Although there is serious modification of vegetation structure and species composition resulting in invasion by weedy species typically associated with non-wetland conditions in the three wetlands, a situation also confirmed by Mutyavaviri (2006) in Zimbabwe, the extent to which geomorphology and hydrology is affected by human use differs. The overall hydrology of Guruguru with a score of 8.5 is rated as critically modified, due to disruptions caused by BR/BF, whereas hydrological modifications were moderate for Dufuya and small for Zungwi. Although BR/BF were introduced in Zungwi, the net effect on hydrology was limited since only a small proportion of the entire wetland is affected. No erosion was observed to be associated with the BR/BR areas. Thus, the BR/BF technique has probably been successful in terms of erosion control even though its impacts on the wetland hydrology may have been greater. Therefore, piloting of new wetland cultivation techniques should be done on a small section of the wetland area. In Dufuya, canalisation compromised hydrological process by increasing water withdrawals and constricting diffusion.

Table 3.14: A summary of the overall biophysical condition of the wetlands based on magnitude of impact scores^a

Wetland component	Wetland name		
	Dufuya	Guruguru	Zungwi
Hydrology	3.5	8.5	1
Geomorphology	3.2	0	0
Vegetation composition	7.2	7	7.3

^aThe ecological condition classes range: 0–0.9 (none), 1–1.9 (small), 2–3.9 (moderate), 4–5.9 (large), 6–7.9 (serious), 8–10 (critical).

On the other hand, the geomorphology of the three wetlands is the least impacted as there is little evidence of erosion and deposition. Where little erosion is taking place in Dufuya, the wetland acts as a ‘sediment sink’. The results of the study indicate that some cultivation methods contribute to degradation of wetland hydrology and vegetation composition although geomorphology is largely unaffected. Therefore, there is danger to generalize too broadly about how wetlands are likely to respond to use, a position also confirmed by Kotze (2011) and Rivers-Moore and Cowden (2012).

The aim of the study was to assess the environmental sustainability of different cultivation systems in wetlands using the WET-Health framework. The results have shown that some on-site wetland cultivation practices rather than land uses in the upstream catchment are responsible for wetland drying and vegetation degradation. Invasion of wetland area cultivated using BR/BF by non-wetland vegetation species is a critical indicator of wetland hydrology alteration, a manifestation of reduction in moist conditions. BR/BF and canalisation have been responsible for wetland drying. However, BR/BF have been observed to be effective in soil erosion control.

A review of literature showed that the WET-Health method has some weakness in that it provides a quick and generalized evaluation of wetland health based on subjective field observations. This makes it difficult to widely understand what is happening in the wetland and the surrounding areas at a finer scale. In light of the limitations of the WET-Health method, this chapter integrated the spatial component (remote sensing) in trying to improve the understanding of the impact of various land uses in both the wetland and its surrounding area. The results have shown that the integration of WET-Health method (which involves questionnaire survey, interviews and field observations) and remotely sensed derived land use

information provides improved understanding of wetland conditions. Therefore, the study show the need for future wetland related studies to shift towards embracing the application of analysed remotely sensed data together with the WET-Health method. The next chapter analyzes the institutional arrangements governing wetland use and management in order to understand their relevance and suitability to promote wetland conservation in Zimbabwe.

3.4 References

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CHAPTER FOUR

INSTITUTIONAL ARRANGEMENTS GOVERNING WETLAND UTILIZATION AND CONSERVATION

4.1 Introduction

Healthy wetlands are known to deliver a wide range of important goods and services to society (Turner et al. 2000; Macfarlane et al. 2007). Wetlands have been sustaining communal livelihoods for centuries in developing countries mainly through cultivation and livestock grazing. However, Zimbabwe has been experiencing a progressive loss of wetlands over the past decades resulting in significant loss of benefits to society (Matiza 1994; Mutepfa et al. 2010). According to Katerere (1994), Zimbabwe has lost a substantial proportion of its wetlands since the time Europeans settled in the country. Wetland mismanagement has been identified as a key factor influencing wetland degradation and loss in the country (Mberek0 2008; Mutepfa et al. 2010). Effective management of wetland ecosystem, instead of preservation, is therefore essential if wetland attributes are to be retained within an ever-changing socio-economic landscape (Boast 1990; Kotze 2010; Macfarlane et al. 2007).

Management and conservation of wetlands is not easy given the complex physical, biological and socio-economic processes determining their existence (Turner et al. 2000). Therefore, research should target the factors at interplay at every wetland site, if they are to be effectively managed. Most studies revealed that successful use and management of wetland systems can be achieved if the resource users, planners and policy makers understand the relationship between wetlands, people and existing human institutions (Shine and de Klemm 1999; Maconachie et al 2008; Dixon et al. 2013) as utilization of wetlands is often influenced by dynamic institutional arrangements peculiar to each place (Dugan 1992; Mitsch and Gosselink 1993). The study of human institutions in wetland management is therefore of significance in maintaining and restoring wetland integrity as appropriate measures can be taken to improve and perfect the existing institutional structures as expected under Ramsar guidelines for wise use of wetlands. This is important in light of previous research findings that institutional conflicts arising from divergent or different priorities and objectives as well as institutional laxity are some instrumental factors behind wetland loss (Chidzonga 1994; Frenken and Mharapara 2002; McCartney et al 2005).

Chuma et al. (2008, 55) defined institutions as *'social arrangements that shape and regulate human behaviour, have some degree of permanency and purpose, and transcend individual*

human lives and intentions'. It is through these institutions that rules governing wetland resource use, control and management are shaped (Murombedzi 1994; Dixon and Wood 2007). Institutions are made up of the institutional environment and institutional arrangements (Chuma et al. 2008). Institutional arrangements, which are the focus of this research, refer to the structure that humans impose on their dealings with each other whereas institutional environment refers to rules governing institutions. Spatio-temporal variations were observed in actual institutional arrangements (Acres et al. 1985; Mharapara et al. 1998; Dixon and Wood 2007; Maconachie et al. 2008). This made institutions to be interpreted differently by different people depending on what they want to achieve. The differences in institutional arrangements thus underline the importance of spatio-temporal analysis of institutions' roles in wetland governance. In Zimbabwe, previous research acknowledged that, if wetland management is to be effective, research should consider institutional changes that can deal with changing conditions (Msipa 2009).

During the pre-colonial period, traditional institutions in southern Africa have been instrumental in management and conservation of natural resources in their socio-political and economic interest (Mogale et al. 2010). Most of the indigenous institutions were relatively effective, resulting in sustainable utilization of natural resources (Dore 2001). While this may be true, it is important to note that pre-colonial population density and land use which would directly and indirectly affect wetlands were significantly different to present and the role of external factors such as new markets which create pressure on wetland resources should not be ignored (de Prada et al. 2014). The capacity of indigenous institutions in natural resources management was however weakened by interference and institutional disruptions initiated by colonial governments. In most developing countries, including Zimbabwe, it has been found that a colonial legacy which was later inherited by post-colonial governments set up a resource governance system which largely ignores indigenous knowledge and commons practice. Nevertheless, traditional institutions have remained largely intact, although they are weak (Dore 2001; Pollard 2005; Mogale et al. 2010). Meanwhile, the degree of co-operation between government resource management agencies and local communities as well as traditional decision making authorities still vary across southern Africa (Mogale 2010).

The level of success of institutions in natural resources governance is determined by dynamic factors. The ability of a given institution to fulfil its mandate depends on power relationships,

source of mandate and political rightness or acceptability (Dugan 1992; Gumbo 2006; Maconachie et al. 2008; Silima 2007). Understanding the role played by institutions is crucial for their conservation (Katerere 1994), although there is little information known about their function and effects on wetland management in Zimbabwe. Imposed institutional arrangements are blamed for participation of external institutions which often ignore views of the local people (Keeley and Scoones 2000; Frenken and Mharapara 2002; Silima 2007; Mbereko 2008). Since it is a requirement under Zimbabwe's National Environmental Policy of 2009 to establish and support an effective institutional framework for sustainable natural resources management, this study investigates the extent to which this can be accomplished in wetland conservation.

In Zimbabwe, wetlands just like any other natural resource are communally used and managed. The communal system of resource ownership entails that communities are in '*de facto*' ownership of the wetlands on behalf of '*de jure*' owners, the state. This exposes wetlands to multi-institutional management since central government departments, local district authorities, traditional authorities, private players, non-governmental organisations (NGOs) and local people participate in wetland management. Therefore, there is need to understand the effect of synergies existing between the various players on the ecological condition of wetlands (Chandra 2011). This is important in light of observations by Russi et al. (2013) that action at all levels by all stakeholders is needed if the opportunities and benefits of working with wetlands are to be fully realised and the consequences of continuing wetland loss appreciated and acted upon.

Generally, in Zimbabwe research information has been lagging behind on how institutions have been evolving, and with what effect, as a way of strengthening institutional performance. The present study would therefore add information to the existing body of knowledge on wetlands in Zimbabwe which Frenken and Mharapara (2002) viewed as inadequate for meaningful planning and decision making. The primary objective of this study is to assess the nature and consequences of the prevailing institutional arrangements towards sustainable utilization of wetland resources in three rural districts of Zimbabwe.

4.2 Field methods

The institutions involved in the utilization, management and conservation of wetlands were identified from relevant policy documents, interviews and questionnaires. A total of 123 households were selected using a stratified random sampling technique. The survey targeted 10% of households from each of the six wetlands studied (Table 2.1). The sample size ensures acceptable representation of the target population (Nyariki 2009). The selected households are utilizing the wetland and/or aware of the wetland's utilization, management and conservation history. A preliminary baseline survey was carried out to familiarize with the study area and identify households with the aforementioned attributes. Local leaders assisted researchers to compile a register of households with the desired characteristics and these formed the sampling frame. Simple random sampling of households from each wetland site was done following the rules of random number table (Dettori 2010). The survey targeted household heads for questionnaires or in the event of their absence, the eldest household member responsible for making decisions.

Household heads questionnaire captured information on socio-demographic characteristics of households including size, duration of stay, period of wetland use, location distance from the wetland, and household head age and gender. The other sections of the questionnaire collected information on households' perceptions on the number, nature and roles of institutions participating in wetland management, inter-institutional relations, the effect of existing institutional arrangements on the ecological conditions of wetlands and proposed reforms to improve institutions' participation in conservation of wetlands and their resources. Some of the questions asked include: Who regulates access to wetland utilization? Who influences management and conservation decisions in the wetland? Are the various institutions involved in wetland use and management very clear about their roles? Is there any conflict among the formal institutions involved in wetland use and management? Lastly, households were asked if at all they participate in wetland conservation and in what way(s) under the existing institutional arrangement.

A second questionnaire was administered to a total of sixty purposively chosen teenagers. Ten were picked from each wetland area, from a household whose head was included in the survey. As future custodians of the resource, it was important to understand their views on wetland governance. The participation of teenagers in the survey depended on their

availability and subject to permission granted by their custodians. A questionnaire for teenagers gathered information on their knowledge of existing institutions and their usefulness in wetland management. Some of the questions asked include: Which institutions are involved in wetland management? Do they make valuable contributions?

The two questionnaires were pre-tested at a different wetland with similar use and population characteristics in order to determine their validity and reliability prior to the main survey. A field test was conducted with ten household heads and five teenagers as these two categories represent the target population for questionnaires. The questionnaire was improved based on feedback from participants. The questionnaires were translated into local languages and self-administered by the researchers and trained research assistants in order to enhance the rate of return. Research participants' consent and permission from local authorities was sought before questionnaires administration and key informant interviews so as to comply with the conditions of ethical approval by the Research Ethics Committee, University of KwaZulu Natal (Reference: HSS/0735/014D).

In addition to household surveys, semi-structured interviews were conducted with key informants (Environmental Management Agency (EMA), Agricultural Technical and Extension Services (Agritex), rural district councils, politicians and traditional leadership) on their role in wetland management and how institutions relate. The EMA is the legally designated national body responsible for overseeing management of all natural resources at all levels, including community level. It was imperative to understand how the organization functions in executing its mandate including challenges in regulating certain forbidden activities in wetlands such as draining for cultivation.

Each rural district council as a custodian of all natural resources including wetlands at local level had an environmental division responsible for management. Therefore, it is important to understand how its efforts complemented initiatives of other participating institutions, including national bodies and non-governmental organizations. Agritex, a government department which provide technical advice to farmers, including those working in wetlands was selected to solicit information on wetland utilisation and management since cultivation is practiced in all surveyed wetlands. Councillors, who are elected political figures representing the government at Ward level in districts, were interviewed to gather information on rules

governing wetland utilization and management since they are responsible for developing by-laws used in local wetland regulation.

Twelve village heads representing 28.6% of the 42 villages' traditional leadership were chosen based on their age and length of service, as these attributes have a bearing on the wealth of knowledge possessed on temporal institutional interactions and change. Two elderly eloquent people above the age of 70 were chosen using a snowball sampling technique in order to tap their institutional memory of wetland resources management structures. Snowball sampling is a technique which relies on referrals to identify other concealed potential target subject(s) (Bryman 2008). Since elderly people constitute a small proportion of human population, village heads assisted in the identification of the first elderly person who later referred the interviewers to the next person.

4.3 Data analysis

Questionnaire data was coded and analysed in the Statistical Package for Social Scientists Version 16 for Windows. A non-parametric Chi-Square test was used at 95% Confidence Interval to show the nature of association between household heads' socio-demographic characteristics (e.g. age, marital status) and households' knowledge of participating institutions and their frequency. Wilcoxon Signed rank non-parametric test was used to determine the difference between total household wetland income and total household income. Qualitative data obtained from key informant interviews was analysed through thematic analysis. This method was used to identify, analyse and report themes across data sets (Braun and Clarke 2006). Themes were identified on the role of different institutions; challenges encountered under the existing institutional set-up and proposed measures to ameliorate wetland utilization and conservation among other study variables.

4.4 Results and discussion

4.4.1 Socio-demographic information of household participants

A total of 91.9% of the respondents, mostly married (71.5%) are unemployed compared to self (4.9%) and formally (3.2%) employed. Dependence on wetlands is high as 97% of the households relied on wetland provisioning services as classified by Millennium Ecosystem

Assessment (2005). There is a good balance of men (51.2%) and women (48.8%) in wetland management (in this case referring to their involvement in activities that are conducted with, in, and around wetlands, to protect, restore, manipulate or provide their functions and values) despite the patriarchal nature of the communities. The duration of stay of each household in the area is on average three decades (Table 4.1). This was mainly influenced by the household head's place of birth and migration. The duration of stay however shows that the people had extensive knowledge of the existing institutions involved in wetlands.

Table 4.1: Socio-demographic information of household heads

Attribute	Mean	Standard deviation*
Household size	5.9 persons	2.78
Age group	46-55	1.59
Period stayed in the area (years)	33.55	20.22
Period of using the wetland (years)	8.81	12.43
Distance travelled (meters)	1209	870.07
Approximate travel time (minutes)	23.39	18.25

* The larger the size of the deviation, the greater variation in responses on the measured attributes.

On average, households have been using wetlands for nine years (Table 4.1). The length of the period is influenced by change in government policy towards wise use of wetlands as stipulated in the Environmental Management Act (2003) and Statutory Instrument 7 of 2007 (Environmental Impact assessment and Ecosystems Protection). This new paradigm brought a shift in wetland governance system since the beginning of the 21st century. The preservationist approach which used to prevail since colonial period under the repealed Natural Resources Act (1951), whereby the government was the sole custodian of wetlands, has been abandoned in favour of incorporating communities in wetland management. During the colonial period (1890 – 1980), wetlands were either preserved as they were fenced and human activities were not allowed inside.

Chi-Square test results further confirmed that no association ($p = 0.11$) existed between duration of stay by each household in the area and the period each household has been using the wetland. This means local people commenced wetland use, especially for cultivation, at different times (Table 4.1). Wetland utilization is voluntary. On average households walk 1.2 km to the wetland, a distance which takes an average time of 24 minutes. Population size of 5.9 persons in households around wetlands is higher than mean household size in the three districts (4.6 persons). Wilcoxon Signed rank test results show that community dependence

on wetlands for income is high as the difference between average total wetland income and average total household income is statistically insignificant ($p = 0.001$). This means a large proportion of household income is derived from wetlands. High population densities and household income obtained from wetlands were also observed around Lake Victoria (Musamba et al 2011).

4.4.2 Wetland ownership

Spatial variations were observed on households' perceptions of wetland ownership (Table 4.2). Given the existence of the communal tenure system, most households (66.7%) and 85% of teenagers indicated that the wetland belongs to the local people. Most local residents' perceptions contradict the legal position in the country that wetland, just like any other natural resource in rural areas, belongs to the state. This shows that local communities confuse user rights with ownership. The differences in community perceptions on ownership is attributed by local authorities and government agencies to lack of knowledge by local people on the requirements of communal resource tenure system which give local people user rights only. Therefore, property right issues in wetlands are marred by confusion. As a result, some key informants further revealed that local people sometimes resist wetland management advice as it is viewed as unnecessary external interference on private property.

Table 4.2: Households' views on wetland ownership, as measured by responses to a questionnaire survey

Institution	Madigane		Dufuya		Chebvute		Tugwi		Zungwi		Guruguru		Total respondents	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Traditional leaders	6	21.4	3	15	7	28	2	18.2	2	9	2	11.8	22	17.9
Local people	16	57.1	14	70	15	60	11	100	13	59.1	13	76.5	82	66.7
RDC	-	-	1	5	2	8	1	9.1	-	-	5	29.4	9	7.3
Central government	9	32.1	8	40	1	4	1	9.1	1	4.5	-	-	20	16.3
God	1	3.5	-	-	-	-	-	-	-	-	1	5.9	2	1.6
Don't know	4	14.3	1	5	-	-	-	-	1	4.5	2	11.8	8	6.5

F-Frequency; "-" – represents no responses. No response indicates that the institution or entity is not known or operating in that area.

Research results in the studied communal wetlands of Zimbabwe on wetland ownership, whereby local people were not clear on the provisions of communal tenure (Table 4.2), are reminiscent to findings in Uganda where poorly defined property rights are associated with

unsustainable practices leading to wetland degradation (Maclean et al. 2009). Therefore, there is need for awareness to clarify ownership to the local communities for the good of wetland conservation. Currently there is considerable ambiguity surrounding the concept of government or local authorities holding wetlands in trust for the people, a view also upheld by Maclean et al. (2009).

4.4.3 Wetland governance structure

The whole wetland management process is driven by several institutions. This includes local institutions (controlled by traditional leaders and wetland committees) and external institutions (such as local and central government agencies and NGOs) as shown in Figure 4.1. Although 80.5% of household heads indicated that institutions are clear with their mandate and roles; the number, importance and purpose of institutions operating at each wetland site is different (see Table 4.3 and 4.4). The way in which different institutions participate is influenced by their diverse institutional mandates and priorities torn between socio-economic and environmental considerations. Therefore, Moses (2008) and Zsuffa et al. (2014) argues that where a complex situation involving different partners operating in coalition exists, it requires a collaborative approach for effective management of wetlands. The successive sections of this article discuss the extent to which this is being achieved in communal areas of Zimbabwe.

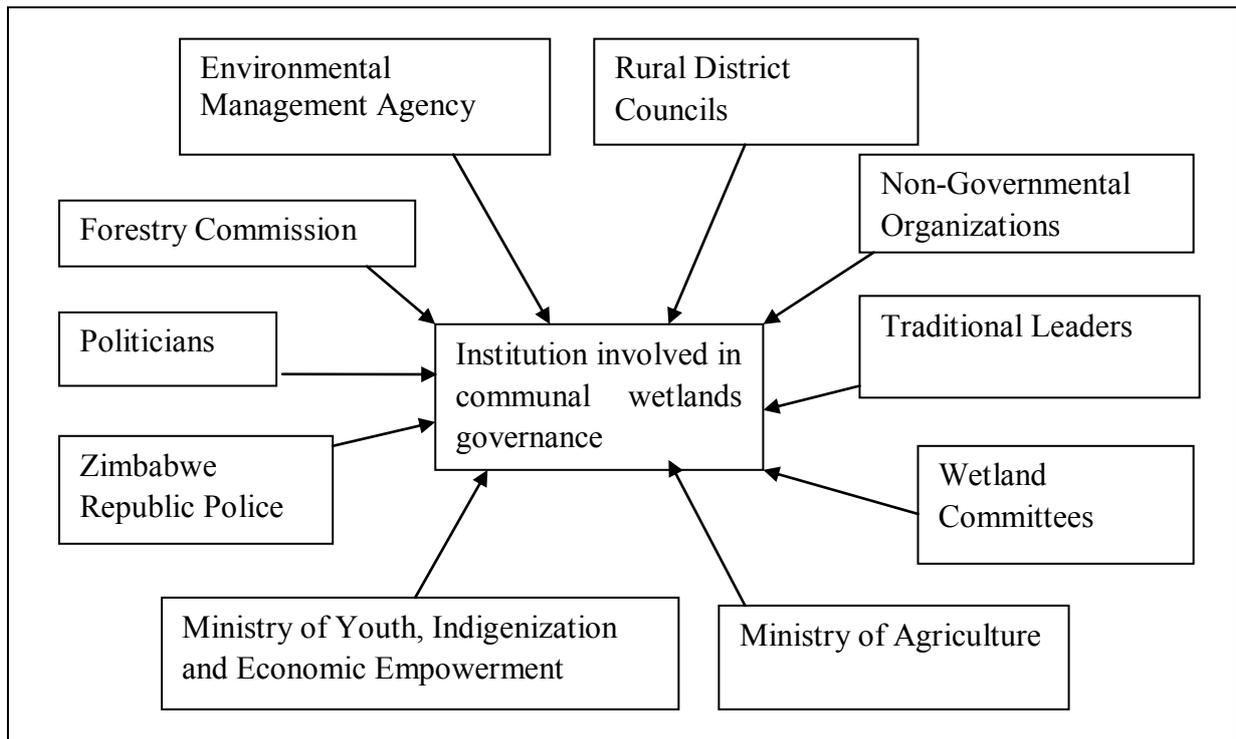


Figure 4.1: Institutions involved in communal wetlands governance.

4.4.3.1 The role played by different institutions in wetland access and utilization

Spatial variations were noted regarding the contribution of different institutions in regulating access and use of the resource (Table 4.3). Most households (69.1%) indicated that traditional leaders are playing a leading role in allocating cultivation plots to local residents. Meanwhile, Agritex demarcates farming plots in and around wetlands and sometimes assist NGOs in the allocation of farming inputs such as seeds and agrochemicals for use in the wetlands. Agritex, by allocating farming plots, therefore influence the number of people accommodated in wetland cultivation. NGOs such as Heifer International and Care also promote wetland utilization by facilitating training workshops on crop production in partnership with Agritex, providing material (such as fence) and financial assistance to wetland farmers. Some livelihood activities promoted by NGOs include sustainable cultivation, fisheries and apiculture.

Table 15.3: Households' views on institutional participation in wetland access and utilization

Institution	Madigane (n=28)		Dufuya (n=20)		Chebvute (n=25)		Tugwi (n=11)		Zungwi (n=22)		Guruguru (n=17)		Total respondents (n=123)	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Traditional leaders	15	53.6	19	95	15	60	11	100	15	68.2	10	58.3	85	69.1
Political leaders	10	35.7	1	5	6	24	-	-	-	-	-	-	17	13.8
EMA	3	10.7	1	5	9	36	4	36.4	4	18.2	-	-	21	17.1
Agritex	14	50	8	40	8	24	-	-	9	40.9	4	23.5	43	35
RDC	-	-	-	-	7	28	2	18.2	7	31.8	4	23.5	20	16.3
Local people	1	3.5	1	5	-	-	-	-	-	-	-	-	2	1.6
Wetland committee	-	-	-	-	4	16	-	-	3	13.6	1	5.9	8	6.5
Mechanization Division	-	-	-	-	-	-	3	27.3	-	-	-	-	3	2.4
NGOs	15	53.6	13	65	16	64	4	36.4	10	45.5	2	11.8	62	50.4
Don't know	-	-	-	-	4	16	1	9.1	-	-	2	11.8	7	5.7

F-Frequency; “-” – represents no responses, which shows that the institution was not known or participating in that area.

Only 17.1% of households revealed that EMA regulate access to wetland utilization. This perception is based on the fact that EMA monitors sustainability of wetland use. Although EMA is involved in regulating wetland utilization, according to EMA officers, not even a single wetland is cultivated with a permit as required by EMA Act (2003) (Subsection 113) and Statutory Instrument (S.I.) 7 of 2007 (Environmental Impact Assessment and Ecosystems Protection) Subsection 20 (1). These statutes expect EMA to grant licences to prospective wetland users (for certain activities such as cultivation, introduction of alien plants and animals and tunnelling, regardless of the scale of operation) with a clear environmental management plan. This situation concurs with Dixon (2005) findings that most developing countries do not openly support wetland utilization and development despite their role in livelihood security. However, a study by Clare and Creed (2014) revealed that the use of wetlands without government permits result in significant degradation of the resource in Canada. Therefore, continued use of wetlands without clear environmental management plans maybe a threat to wise use of the resource, as evidenced by degradation at Guruguru and Zungwi where wetlands were cultivated using furrows and ridges.

Furthermore, local and central government agencies revealed that they are handicapped by politics which makes it difficult to evict illegal wetland users whose basic livelihoods are dependent on the resource. Politicians promote livelihood benefits through cultivation at the

expense of wetland conservation. As a result, councillors breach wetland law by sanctioning encroachment of gardens into the wetland core in violation of wetland law and expectations of local tradition and custom. This is common in Madigane where drying of wetland fringes is increasing. The wetland core is the preserved area which is not supposed to be disturbed by human activities such as cultivation and livestock grazing since it is regarded as a sacred permanent source of water by local people.

Wetland committees elected by wetland beneficiaries (who are local people) directly regulate use of the resource in Chebvuterambatemwa and Tugwi as revealed by 6.5% of households. Therefore, wetland committees were identified to poorly participate in wetland access and utilization. These locally organised committees determine the number of people accommodated by each wetland by approving new applicants in consultation with traditional leaders and Agritex. Meanwhile, Ward youth officers, operating under the Ministry of Youth, Indigenization and Economic Empowerment promote participation of more youth in wetland use as a strategy to empower them for better lives as championed in the country's economic blueprint, Zimbabwe Agenda for Sustainable Socio-Economic Transformation. Youth officers ensure that at least 30% of farming plots are allocated to youth at Tugwi. Therefore, the involvement of several institutions at each wetland site, mainly in an uncoordinated way, may explain why 94.3% of households revealed that there is discord in regulation of wetland access and use a situation which has been exerting pressure on wetland ecosystem as the number of users has been gradually increasing.

4.4.3.2 The role of different institutions in wetland management and conservation

The EMA and traditional leaders are key stakeholders influencing policy direction on wetland management and conservation, although other institutions (Agritex, Forestry Commission, NGOs, RDCs, Wetland committees,) played peripheral but important roles at specific wetland locations (see Table 4.4). Although the EMA infrequently participate in wetland conservation through education, awareness, monitoring of legal adherence, initiating wetland protection projects (e.g., at Chebvuterambatemwa) and monitoring illegal extension of farming plots, the institution is well known by local communities due to its punitive measures on degrading activities, including jail sentences, as confirmed by 42.2% of household respondents and 71.7% of teenagers. Traditional leaders monitor wetland abuse by checking

local people's compliance to local policies and often punish the culprits. The effectiveness of traditional leaders is attributed to their closeness to the people cemented by kinship ties and mutual respect for existing social relations.

Table 4.4: Households' views on the influence of different institutions in wetland management and conservation decisions (as measured by responses to questionnaire survey)

Institution	Madigane		Dufuya		Chebvute		Tugwi		Zungwi		Guruguru		Total respondents	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Traditional leaders	20	71.4	13	65	10	40	7	63.6	-	-	1	5.9	51	41.5
Councillor	9	32.1	3	15	4	16	1	9.1	-	-	-	-	17	13.8
RDC	2	7.1	4	20	4	16	1	9.1	-	-	2	11.8	13	10.6
Wetland committee	4	14.3	2	10	13	52	1	9.1	2	9.1	2	11.8	24	19.5
EMA	15	53.6	9	45	15	60	9	81.8	4	18.2	-	-	52	42.2
Agritex	5	17.9	3	15	8	32	4	36.4	10	45.5	7	41.2	37	30
Research institutions	-	-	-	-	-	-	-	-	1	4.5	2	11.8	3	2.4
NGOs	4	14.3	2	10	1	4	-	-	-	-	1	5.9	8	6.5
Forestry Commission	-	-	-	-	10	40	-	-	2	9.1	-	-	13	10.6

F - Frequency; "-" – represents no responses. No response indicates that the institution was not participating in that area.

The Forestry Commission's activities are mainly confined to monitoring of vegetation cover in the catchment area of wetlands. This situation according to 87.8% of surveyed households and 23.3% of the teenagers enhanced catchment protection as deforestation was reduced. The conservation of catchment area is critical given observations that its degradation contributes to wetland loss (Mharapara et al. 1998). In Dufuya and Chebvuterambatemwa wetlands, councillors monitor illegal activities (such as drilling of several wells, garden encroachment) and co-ordinate community meetings facilitated by NGOs and government departments on sustainable wetland utilization practices.

Agritex equips wetland users with knowledge on sustainable wetland utilization by promoting adoption of conservation farming techniques, since erosion was identified to be a major cause of wetland degradation (Whitlow 1989). In Chebvuterambatemwa, Dufuya, Madigane and Tugwi wetlands, basin tillage and composting are encouraged by Agritex and NGOs, although they are not wholly embraced by all farmers. For instance, in Madigane composting is practised by 42.9% of farmers. However, principles of conservation farming such as minimum tillage were violated by some farmers who use ox-drawn ploughs in land preparation so as to reduce labour demand for weeding. This practice was observed to

increase the chances of soil erosion in wetlands as in the case of Madigane, a situation also confirmed by Kotze (2011) in Malawi.

Non-governmental organizations on the other hand provide cash-stripped communities with material resources such as fence to prevent wetland degradation by livestock, especially through cattle trampling. Given the prevailing semi-arid conditions, wetlands were observed to provide water and pasture to livestock. Nevertheless, cattle trampling was reported by 9.8% household heads and 26.7% teenagers to be responsible for desiccation in unfenced wetland sections of Chebvuterambatemwa and Dufuya. The effect of cattle trampling on wetlands was also well studied (Sibanda 2005; Dahwa et al. 2013; Morris and Reich 2013). Therefore, fencing of wetlands reduced wetland loss to livestock.

Wetland committees, with the assistance of users, guard wetlands, apprehend illegal users and report illegal activities to relevant government agencies. Some prohibited activities mentioned by households include hunting, cutting of thatch grass and trees, digging worms, extension of gardens beyond demarcations set by Agritex and monitoring of fence vandalism. Poor coordination of wetland management by committees in Guruguru and Zungwi is perceived by 84.6% of farmers to be responsible for the current deterioration of wetland conditions. However, at Chebvuterambatemwa, Dufuya and Tugwi, most households (55.4%) indicated that the committees assisted in effective implementation of agronomic (e.g., use of manure) and vegetative measures (e.g., vegetation strips) to prevent or mitigate the effects of wetland cultivation.

The role of wetland committees in coordinating wetland management activities and the spatio-temporal variations in the effect of their performance was also acknowledged in Ethiopia (Dixon 2005). In summary, the ability of institutions to assist wetland users to utilize wetlands in a way that promote conservation depended on their level of coordination and participation of recipient communities. However, the performance of the EMA is affected by inadequate resources as discussed later and this underscores the need to improve its performance given its observed potential to effectively regulate human activities in wetlands.

4.4.3.3 Frequency of institutions participation in wetland use and management

Traditional leaders are more visible in both wetland use and management as they work with local people more than EMA, RDCs and NGOs (Figure 4.2). The high frequency of traditional leaders is influenced by the fact that they live close to the people and wetlands as discussed earlier. The EMA is more reactive in wetland management resulting in its low frequency of visits as indicated by 60.1% households. EMA occasionally responded to wetland degradation threats such as fire instead of routine management of the resource. RDCs, despite having a department responsible for environmental conservation, their presence was negligible. Therefore, local and national government institutions remain largely unknown because of low participation. Poor participation of government departments was also identified as a common problem in Ethiopia (Dixon et al 2013). Key informant interview results revealed that the proper functioning of RDCs and EMA is constrained by inadequate human and financial resources resulting in their ad hoc visits. On the contrary, Agritex is involved more frequently in wetland cultivation. This is attributed to the institution's operations at micro-level (i.e. ward-based) in promoting food security.

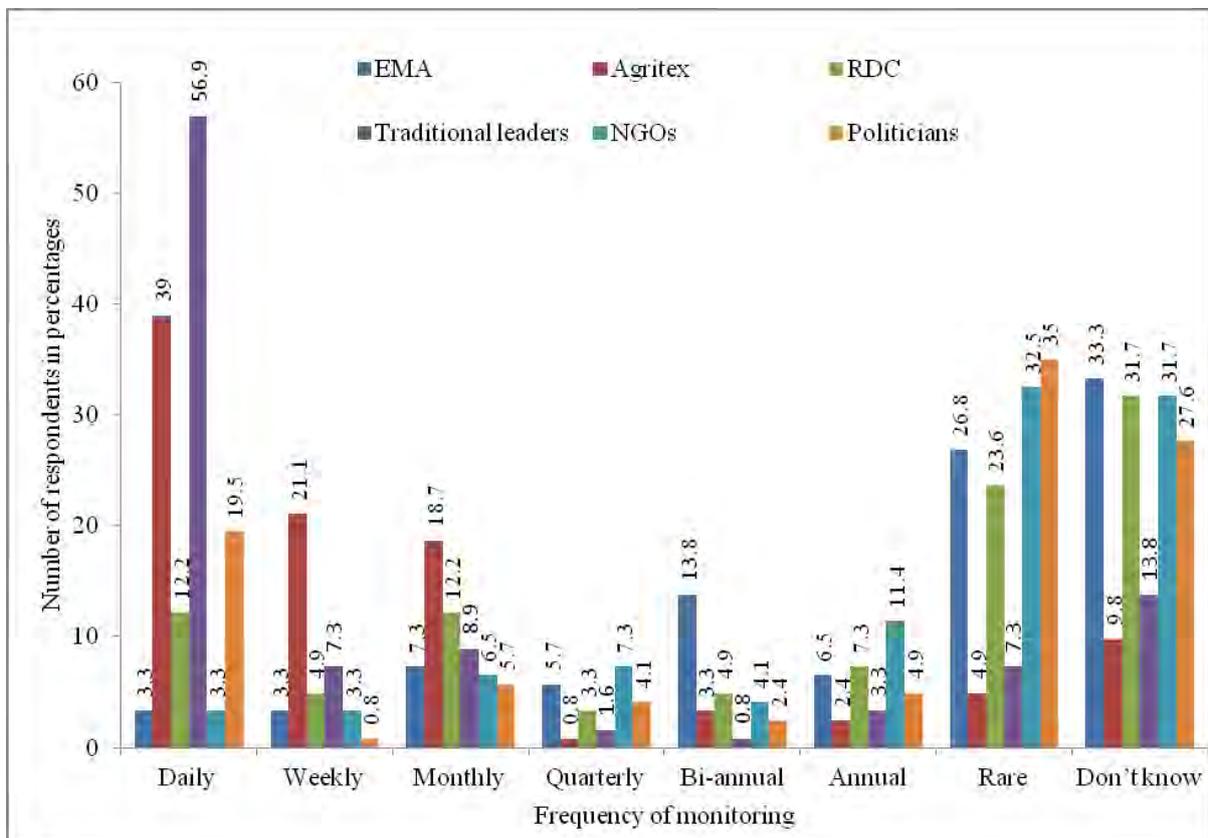


Figure 4.2: Households' views on institutions' frequency of participation in wetland governance

The significance of political leaders and NGOs is restricted to specific wetlands (see Table 4.3 and 4.4). Generally, NGOs participate at the initial stages of project development and implementation and taught local people wise use strategies when donor funding was still available. Wise use is basically maintenance of a wetland's ecological character whilst safeguarding human interests (Ramsar Convention Secretariat 2010). Therefore, in Guruguru and Zungwi wetlands, the departure of NGOs resulted in wetland degradation as local communities mismanaged the cultivation technique implemented by failing to maintain furrows and ridges as expected by project developers, a situation confirmed by 9.8% of household heads. It was also noted that councillors effectively participate in wetland conservation where they stay closer to wetlands and access benefits. This may explain why they are largely unknown in most wetlands, except in Madigane. In a nutshell, the frequency of participation in wetland management and conservation by EMA, RDCs and NGOs was poor despite observations by Mwakubo and Obare (2009) that the number of visits by institutions is a significant determinant of the willingness of local people to participate in wetland conservation. This may show that there is need for local institutions to take a leading role in wetland management.

4.4.3.4 Relationship between different management institutions

Relationship is defined by the linkages and interactions between the various stakeholders in wetlands. The way in which institutions relate in wetland management is critical as a harmonious approach normally benefit the resource through conservation due to elimination of existing or potential conflicts as revealed by all key informants and 83.7% of households. The involvement of more than one institution at each wetland results in either complementary or contradictory roles. Relations are sometimes less cordial due to overlapping and conflicting roles. Generally, traditional leaders, EMA and RDCs consult and complement each other's efforts as they regularly embark on collaborative meetings, workshops and campaigns as confirmed by some key informants and 34.4% of households.

EMA and RDCs also operate through the same environmental monitors at local level, a situation which assist them to synchronize their operations. Environmental monitors are voluntary individuals who monitor and co-ordinate natural resources management at Ward

level. RDCs and EMA sometimes incorporate the Zimbabwe Republic Police (ZRP) when enforcing wetland law and policies. This enables pooling together of meagre resources available for wetland management. Where EMA, RDCs, ZRP and traditional leaders effectively worked together, illegal activities in wetlands (e.g., Chebvuterambatemwa, Dufuya and Tugwi) were reported by some key informants to be low.

Non-governmental organizations' operations in wetlands are sanctioned by RDCs who in turn monitor their activities. Nonetheless, NGOs are sometimes at loggerheads with RDCs, especially where they deviate from their approved conditions of operation, thereby endangering wetland ecology by indirectly influencing unsustainable wetland utilization. A case in point is whereby wetland users in Dufuya were duped by a NGO to enter into contract farming without the knowledge of the RDC resulting in expansion of wetland farming as farmers endeavoured to improve their net gains. Therefore, little verification of the requirements and follow-up for development projects by local authorities pose challenges in wetland management, a position also confirmed by Morzaria-Luna et al (2014).

Relations between EMA and NGOs are not always cordial. They often pull in different directions due to divergent institutional motives. EMA mainly focus on wetland conservation whereas NGOs primarily focus on food security through nutrition gardens and livestock production. The role of NGOs in improving agricultural productivity in wetlands was also acknowledged by Kotze (2011). As each institution execute its mandate, different institutional goals sometimes degenerate into management conflicts as confirmed by 5.7% of surveyed households. The local people capitalize on these conflicts to extend wetland cultivation or become reluctant in the implementation of conservation measures. However, where NGOs complemented EMA's conservation initiatives, relations are good and wetlands are better conserved as in the case of Chebvuterambatemwa. NGOs have mutual relations with Agritex as their focus is largely the same, that is, to increase agricultural production and improve household food security.

On the other hand, Agritex's effective participation in wetland management is compromised by inadequate acknowledgement of their efforts by EMA and RDCs. Agritex is only invited for wetland commemorations, for example, on International Wetland Day, despite the fact that it often works with farmers in wetland cultivation as shown in Figure 4.3. However, the

attitude of EMA towards Agritex has been changing in some areas, in particular, Chebputerambatemwa wetland. Where they worked together, Agritex and EMA complement each other in promoting wetland conservation as Agritex also monitor and discourage encroachment of gardens into wetland. Wetland committees are present at all sites and were recognised by other institutions involved in wetland management. This was confirmed by 94.3% of wetland users. Therefore, wetland committees are a vital entity in communal wetland use.

Relations between EMA and councillors are sometimes bad especially where the latter despise EMA's efforts for political reasons as in the case of Madigane. However, a platform has been created whereby institutions like EMA, RDC environmental officers and councillors meet to deliberate on environmental issues including wetlands at district level. Nonetheless, the implementation of agreed resolutions is poor due to divergent institutional goals and priorities. For instance, unlike EMA whose focus is on environmental management, RDCs' mandate is torn between environmental protection and improving livelihoods of the people, with the later given precedence. Therefore, balancing wetland conservation and livelihood benefits remains an area causing conflicts between institutions. This result was confirmed by IWMI (2014) findings that objectives of wetland conservation and livelihood requirements are not always congruent.

4.4.4 The role of wetland users in wetland management and conservation

Although 82.1% of households indicated that they participate in wetland conservation, there were variations in ways of participation. Conservation activities carried out by surveyed households include maintenance of fence (58.5%), monitoring of illegal activities in the wetland such as cattle grazing and extension of gardens (72.4%), conservation farming (54.5%), catchment protection (7.3%) and construction of fireguards (3.3%). The research further examined the extent to which socio-demographic characteristics of households influence people's participation in wetland management and conservation. Chi-Square test results revealed a statistically significant association between marital status ($p = 0.03$), household size ($p = 0.00$) period stayed in the area ($p = 0.00$), period of utilizing the wetland ($p = 0.00$) and distance travelled to wetland ($p = 0.00$) and the number of households participating in conservation.

Statistical analyses results therefore show that those residents who live in proximity to and have been utilizing wetlands for a long period participate more in the conservation of wetlands compared to new entries and those who stay in distant locations. This may be an indicator that these people protect wetlands because they enjoy benefits of cultivation. Married people participated in conservation activities more than widows and single persons and this also applies to households with large population size. This may be attributed to division of labour since these households have a large pool of labourforce at their disposal. Thus, household size, marital status, period of utilizing the wetland, duration of residence and location of a household from the wetland should be considered in planning for wetland management and conservation as they directly influence local participation unlike age ($p = 0.14$), gender ($p = 0.34$), education level ($p = 0.83$) and employment status ($p = 0.10$) of the household head.

4.4.5 Benefits of the current institutional arrangement to local communities and the wetlands

Most of the households (63.4%) indicated that they are benefiting from wetlands by directly harvesting wetland products or practising agriculture, a situation they attributed to regulation of wetland use by existing institutions. Traditional leaders and wetland committees play an integral role in supporting wetland use activities with the assistance of government departments (e.g. Agritex) and NGOs. The prevailing governance structures therefore allow wetland users to increase their agricultural yield (as revealed by 54.5%) and in some cases expand their livelihood options through fishing and apiculture (4.1%). This result tallies with that of Mujaju et al. (2013). Wetland benefits in turn act as incentives to protection of wetland ecosystems as in the case of Chebvuterambatemwa, Dufuya, Madigane and Tugwi. For instance, in Madigane, farmers allocated wetland plots monitor protection fence from vandalism. Therefore, the incorporation of local people in wetland use governance structure assists in sustainable wetland conservation. According to 43.9% of households, the existing institutional arrangement improved co-operation between traditional leaders and government institutions, as they work towards a common goal of sustainable utilization.

4.4.6 Challenges affecting wetland governance under current institutional arrangement

The major bottleneck to the current institutional structure efforts is lack of co-ordination and dominance of some institutions. NGOs use their financial muscle to dominate wetland use and conservation decision making. Absence of a clear institutional framework act as an obstacle to effective wetland governance as institutional duties are not clear as confirmed by 87.8% households. In some cases, institutions like EMA identify themselves as the only entity with the sole mandate to manage wetlands without acknowledging efforts of other institutions, a position which confuses users on whose advice should be followed. The distant location of institutions such as EMA often makes assistance rendered to local communities insignificant as their visits were reported to be infrequent. Therefore, 5.7% of households indicated that there is need to decentralise EMA's operations to Ward level in order to increase its involvement in wetland management.

The current institutional arrangement is also affected by confusion emanating from differences in institutional dimensions. Different fines are charged by EMA, ZRP, RDCs and traditional leaders for similar wetland offences. Agritex and NGOs are mainly concerned with increasing productivity hence sometimes could not prevent people from engaging in farming practices that contribute to wetlands loss. The differences between institutions led wetland users to comply with favourable views (that is, those which allowed them to engage in activities such as cultivation which gave them direct benefits) regardless of their effect on wetland integrity. This may explain why traditional leaders and wetland committees are more popular and accepted by local people than EMA which largely prohibit wetland draining for cultivation.

Wetland committees' dictatorial tendencies, whereby they disregard views of other wetland users, sometimes result in conflicts to the detriment of wetlands. For instance, at Guruguru and Zungwi, the committees did not value wetland management contributions by other users, a situation which brought disharmony and caused subsequent drying of the wetlands due to mismanagement of the implemented cultivation technology, locally known as '*ngwarati*'. Politicization of wetland use and management, especially by councillors was another concern as it undermines the efforts of government agencies such as EMA. Access to wetland use was sometimes done on political grounds as it was determined by the political affiliation of individual households. Moreover, the participation of political leaders in most cases was

driven by political ambitions rather than the need to conserve the wetland, a situation also observed in Nigeria by Adekola et al (2012). Therefore, political interests took precedence ahead of wetland conservation.

There was also inconsistency in wetland policy articulation by institutions involved in wetland management, a situation which left wetland users confused on their status in wetland management process. For instance, at Chebvuaterambatemwa households which were involved in sustainable wetland utilization with the support of EMA were threatened with expulsion by officials from the same Agency who notified them that they are illegal users. This proclamation was made despite the wetland having been hailed as a symbol of sustainable utilization in Midlands province in year 2012. This brought disgruntlement to local people resulting in commencement of wetland degrading activities. Institutions like Agritex mainly participate in donor funded wetland management projects. This normally brought mistrust and tension as locals suspiciously view their motive as to enjoy donor funds.

4.4.7 A proposal for institutional structural reforms

Most problems in wetland governance are shown to emanate from poor co-ordination and consensus between institutions. Therefore 87.8% of households indicated that there is need to reform the current institutional set-up. This can be achieved by creating a framework to facilitate institutional meetings where common goals and work plans are drafted so that unity of purpose in wetland conservation can be fostered between all institutions and local people. The country can achieve this by drawing some lessons from Uganda whose system in wetland governance has been improving over the years (Moses 2008; Maclean et al. 2009). In Uganda, there is an elaborate institutional arrangement for wetland management, as this responsibility is vested in the Wetlands Inspection Division (Moses 2008). Furthermore, given multi-institutional involvement in wetland management, for co-ordination purpose, the National Wetlands Inter-Agency Co-ordination Committee was established in Uganda and its operations are replicated at district and local levels.

The establishment of wetlands inter-agency co-ordination committee in Zimbabwe would enhance dissemination of wetland management and conservation information as well as monitoring of unsustainable practices in wetlands using sustainable land management tools

like WOCAT. Moreover, local people should be educated on the role and importance of different external institutions to minimize attrition based on divergent views and expectations. This would facilitate easy acceptance of external institutions' advice and support; hence elimination of sour relations between some institutions and local people. Clarification of institutional mandates through this platform would further iron out confusion amongst people on their roles and relationships. However, the success of the committee will depend on decentralisation of its operations and provision of resources for their work. The committee should include wetland users, traditional leaders and wetland committees so as to tap their indigenous knowledge on wetland values and management in their best interest.

The role, relationship and consequences of institutional arrangements governing wetland access, utilization and management in three rural districts of Zimbabwe were analysed in this chapter. The findings generally demonstrate that a multi-institutional structure, though with spatial variations in terms of composition, regulated both utilization and conservation of wetland resources. The degree of participation by different institutions varies, with institutions responsible for promoting wetland conservation less visible than those promoting use; hence differences in level of wetland conservation. Therefore, the next chapter examines the policy framework guiding wetland management and its bearing on wetland conservation.

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CHAPTER FIVE

EXPLORING THE MISSING LINK IN THE AWARENESS AND THE IMPLEMENTATION OF WETLAND POLICY AND LEGISLATION

5.1 Introduction

Wetlands provide the basis of human livelihoods in Africa through ecosystem services (Rebelo et al 2010; van Dam et al 2014). The extent of wetlands in Africa is not known due to little coordinated scientific research investigation, the absence of a single classification system and inconsistent mapping policies and scales (Finlayson and Spiers 1999; Schuyt 2005). No single definition of wetlands exists, however, wetlands are generally described as areas that are periodically or continuously inundated by shallow water or have saturated soils which support vegetation adapted to such conditions (Whitlow 1984; Mitsch and Gosselink 1993; Breen et al 1997; Tooth and McCarthy 2007). Zimbabwe adapted the Ramsar definition of a wetland. Ramsar defined a wetland as “any area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is flowing or static, fresh, brackish or salt, and includes riparian land adjacent to the wetland” (Zimbabwe Environmental Management Act 2003:11).

Research estimates reveal that wetlands constitute approximately 4.7% (or some 1 150 000 km²) of sub-Saharan Africa (Rebelo et al 2010) and 3.6% (or 1.28 million hectares) of Zimbabwe’s total land area (Whitlow 1985). Absence of comprehensive details on wetland coverage makes it difficult to design and implement adequate management strategies at various scales, especially in developing countries with resource limitations. Therefore, a wetland policy can assist in the management of wetlands even where an inventory is absent as there would be a clear basis to regulate activities that degrade the ecosystem.

Wetland use and conservation is governed by locally and internationally initiated policies. Environmental legislation governing wetland management worldwide has increased dramatically since the 1970s (Island Press 2007; Ramsar Convention Secretariat 2010). The Ramsar Convention, designed specifically to spearhead wetland conservation worldwide, emerged as a result of the need to warn people of the effects of degradation on the environment. However, wetlands continue to be lost annually despite a large number of international agreements (Turner et al 2000; Ma et al 2013; Russi et al 2013; Zheng et al 2014). It is estimated that more than 50% of the original global extent of wetlands has been degraded over the last century and this is mainly attributed to human activities (van Dam et al 2014). Zimbabwe is a signatory to the Ramsar convention and is expected to craft and implement policies aimed at promoting wise use of wetlands other than conservation of those

listed. Gogo (2013) observes that despite existing conservation efforts, results of wetland mapping in Zimbabwe, though not consolidated, indicate that there is serious wetland loss. Similarly, Madebwe and Madebwe (2005) note that in Shurugwi district, wetlands were lost at an average rate of 0.6% per annum.

Wetland ecosystems management remain a salient issue which deserves more research in Africa. Van Dam et al (2014) note that most countries are starting to develop wetland policies to protect fragile ecosystems threatened by human and natural processes. Mutyavaviri (2006) also argues that the absence of policy compromises wetland protection especially where users do not engage in self-imposed sustainable practices. However, growing food insecurity and climate change have hampered the successful implementation of existing policies and legislation aimed at sustainability and environmental protection in most sub-Saharan African countries (Adekola et al 2012; van Dam et al 2014). Few studies have been conducted to examine why regulatory compliance has been so poor in most of Africa (La Peyre et al 2001; Adekola et al 2012) and Zimbabwe is not an exception (Chingwenya and Manatsa 2007). Periodic evaluation of policy outcomes is essential to determine barriers, unintended outcomes or unsuccessful aspects of policy implementation (Clare and Creed 2014; Dale et al 2014).

Acts such as the Water Act (1927 revised 1976), the Natural Resources Act (1941 revised 1976, 1981 and 1996), the Public Streambank Protection Regulation (PSPR) (1952) and the Land Husbandry Act (1951) were crafted to prevent degradation of wetland resources due to severe draining (Whitlow 1985). The Natural Resources Act prohibited human use of wetlands whereas the Water Act and PSPR specified distance from which human activities were supposed to be undertaken from the wetland boundary to ensure their protection. The Land Husbandry Act provided for the control and utilization of land, including wetlands. However, these successive laws did not effectively address issues of wetland destruction due to absence of deliberate efforts by government to curb unauthorised wetland use (Katerere 1994), poor implementation of legislation (Magole et al 2010; Murombedzi 1994) and resistance by local communities to government's top-down management approach which ignored human aspects of conservation (Keeley and Scoones 2000). Therefore, persistent wetland degradation raised questions on the acceptability of the legislation to the general public and the effectiveness of the implementation strategies.

Rhodesian colonial pieces of legislation (1890-1980) regarding wetlands remained in force in the post-colonial era until the enactment of the Environmental Management Act (EMA Act) (2003), Statutory Instrument (S.I.) 7 of 2007 (Environmental Impact Assessment and Ecosystems Protection) and Section 73 of Constitution of Zimbabwe Amendment (No. 20) Act 2013. Section 73 seeks to promote wetland conservation and ensure ecologically sustainable development based on use of wetland resources while encouraging social and economic development. The EMA Act provides the legislative framework on how this can be achieved. S.I. 7 provides details on how the provision of the EMA Act should be implemented. The new legal framework aims to achieve sustainable wetland utilization based on a permit system for easy monitoring and regulation of human activities. The purpose of the permit is not to prohibit agriculture, but to ensure that cultivation and other land uses do not contribute to ecological degradation. The permit system therefore assists regulatory authorities to have an inventory of wetlands which can be used to effectively monitor the effects of land uses.

Application for use of communal wetland (e.g. cultivation, draining, introduction of any exotic animal or plant species) should be made with the consent of the local authority. A non-transferable user permit is issued by the Environmental Management Agency (EMA) for one year provided an application accompanied by an appropriate fee is made and approved. Keeley and Scoones (2000), however, observe that there was no meaningful consultation during the development of the EMA Act; a position which raises questions on its relevance and possible acceptability. Research is yet to be conducted to assess the effectiveness of this new legal dispensation in addressing sustainable wetland conservation. The suitability of policy interventions in wetlands needs to be scrutinized as wetlands have been lost inadvertently due to badly co-ordinated or poorly designed policies loosely related to wetlands (Turner et al 2000).

This article explores stakeholder's perceptions of the efficacy of the current policies and legislation meant to conserve wetlands in communal areas of Zimbabwe. The study was conducted against the background that wetland degradation is persistent in Zimbabwe regardless of the existence of wetland use related laws. The research sought to answer the following research questions; (1) to what extent are local communities aware of policies and

legislation governing wetland management and their rational?, (2) why do local communities disregard provisions of those policies and legislation?, (3) what are the hindrances to effective implementation of wetland policies and legislation?, (4) what is the state of wetlands in light of the preceding questions? It is pertinent to answer these research questions given the fact that awareness, enforcement and compliance are key components to the success of any wetland regulatory program (Dale et al 2014; Clare et al 2011).

5.2 Materials and Methods

5.2.1 Data collection and analysis

A mixed research design based on a combination of quantitative and qualitative approaches was used in both data collection and analysis. Mixed research method enhances results quality and allows for corroboration, complementarity and expansion of results (Creswell 2003; Bryman 2006). Questionnaires, semi-structured interviews and document review were used to gather information. Ethical approval for human subjects (questionnaires and interviews) was obtained from the Humanities and Social Sciences Research Ethics Committee, University of KwaZulu Natal (Reference: HSS/0735/014D).

A questionnaire comprising of open-ended and closed-ended questions was designed to collect data from households adjacent to wetlands, in particular those utilizing or living near the resource and have some knowledge of wetland utilization and management history. A preliminary survey was first conducted to identify target households. This was accomplished with the assistance of community leaders (village heads and councillors) who supported the researchers to compile a register of intended participants (possessing abovementioned attributes) which formed the sampling frame. A sample of one hundred and twenty three households representing 10% of the target population, a minimum threshold accepted for a representative sample (Nyariki 2009), was selected using a stratified random sampling technique. This involved randomly selecting proportional samples from the six wetlands studied (Table 2.1), to ensure high representation from each site (Harding 2006). Household head or the eldest person who make decisions in the absence of the head was interviewed.

Once the sample size was determined and the intended participants were known, the questionnaire was pre-tested for validity, reliability and acceptability. In this case, a field test was conducted at a different wetland located in Vungu RDC, with similar land use types. The

wetland was selected on the basis that the users and people around belong to the two major ethnic groups in the study area, that is, Ndebele and Shona. Ten household heads were purposively selected and the pilot sample was equally apportioned between the two ethnic groups. Questionnaire piloting assisted to safeguard time wasting, collection of useless data and check for appropriateness of questions during a full scale survey. Questionnaires were self-administered to ensure that responses were from the intended subjects. Questions were translated into Ndebele and Shona to enhance understanding.

The questionnaire captured data on households' socio-demographic characteristics, knowledge of wetland law and policy and their rational, the extent to which local people adhered to policy stipulations, challenges undermining effective use of legislation as a tool to promote sustainable wetland utilization and the state of wetland biophysical conditions in light of changes in legislation. A review of households' perceptions and attitude to policies and legislation was critical for the establishment of effective governance systems to manage wetland ecosystems.

Key informants such as District Environmental Management Agency officers (DEMAO), Rural District Council Environmental officers (RDCEO), Agricultural, Technical and Extension Services (AGRITEX) officers, traditional leaders, councillors and elderly people were purposively selected for semi-structured interviews. The DEMAOs are local custodians of national environmental law and supervise its implementation; hence they answered questions on how existing legal provisions affect wetlands and people's livelihoods. Officers from AGRITEX, a government institution with the mandate to provide advisory services to farmers, provided information on farming patterns and users' perceived attitude of policies and legislation governing wetlands utilization and management.

The Rural District Council Environmental officers monitor implementation of by-laws as outlined in the Rural District Councils Act (1988). Considered as local watchdogs for development and natural resources conservation, RDCEOs provided details to local people on the appropriateness of by-laws in sustainable wetland utilization. Ward Councillors, who are elected political figures representing administrative Wards within districts, participate in the formulation and implementation of by-laws. Given their knowledge of wetlands and related by-laws, Ward councillors provided information on the relevance and acceptability of

existing legislation. RDCEOs and councillors in this research were viewed as an integral part of wetland governance structure at local level.

Twelve village heads (representing a total of 28.6% of the 42 villages' traditional leadership) were selected from the six wetlands studied. The key attribute considered in their selection was length of service with a bearing on their wealth of knowledge accumulated. Village heads provided spatio-temporal information on wetland governance policies and legislation. The Traditional leaders Act (1998) empowered them to ensure adherence to environmental law and policies in their areas of jurisdiction. Two elderly people above the age of seventy were selected from each wetland site using a snowball sampling technique. The two elderly people provided historical information on wetland utilization and management strategies. Snowball sampling, a recruitment technique which relies on referrals in identifying other potential subjects (Bryman 2008), was used to select the elderly people who represented a small proportion of the entire community population.

Appointments were made before interviewing identified key informants. Face to face interviews, intended to collect high quality data (Mathers et al 1998), were conducted at the workplace, home or a convenient place suggested by the interviewee using a template which had been compiled. All interviews were audio recorded and notes were taken by the interviewer to capture important non-verbal cues and relevant points for further probing. Audio recording interviews gave an accurate summary of the interview as well as a reference point as they were repeated by the interviewer to have clarity on certain points during data analysis.

Documents obtained from government departments, Midlands State University library, internet and wetland committees' constitutions and minutes of their meetings were reviewed to determine the existence of local and national wetland policies and legislation. The researchers used this literature to understand how the policy and legislative framework governing wetlands management evolved over the years. Reviewed documents further assisted in determining the adequacy of wetland law and its relevance to rural people whose livelihoods largely depended on natural resources.

Qualitative data obtained through open-ended questions in questionnaires, semi-structured interviews and document review was summarised in a descriptive and explanatory manner under defined sub-headings (Shively and Lukert 2011). Thematic analysis, which is a qualitative analytic method for identifying, analysing and reporting patterns (themes) within data (Braun and Clarke 2006), guided the researcher to interpret interviewees' accounts. The emerging themes from questionnaires' open-ended questions were grouped, quantified and presented as descriptive statistics or in tables. Quantitative data generated through closed-ended questions in questionnaires was coded, edited and analysed using SPSS version 16.0 for Windows at 95% confidence interval. A non-parametric Chi-Square test was used to show the association between socio-demographic characteristics of households and their knowledge of wetland law as well as the preferred approach to improve wetland management.

5.3 Results and discussion

5.3.1 Local community's knowledge of wetland policies and legislation

The majority of household respondents (61.8%) were not aware of the existence and rationale of laws (excluding traditional customary laws) governing the use and conservation of the wetlands. This may explain why there was widespread illegal use of the six wetlands in contravention of the national law and by-laws which required wetland users to obtain permits. The EMA Chapter 20:27 Section 113(2) clearly states that "no person shall, except in accordance with the express written authorisation by the Agency, given in consultation with the Board and Minister responsible for water resources" use wetlands for certain activities. Although there was no specific definition of wetland use in the Act, S.I. 7 of 2007 outlined activities that should not be undertaken without permits, with draining for cultivation, which is a common land use in communal areas included on that list. Illegal use of wetlands was accompanied by widespread desiccation and shrinking of wetland size as revealed by Madebwe and Madebwe (2005). The findings are similar to Clare and Creed's (2014) study conducted in Canada, where about 80% of wetlands which were used without permits, were subsequently lost.

Local people's knowledge of wetland legislation was poor regardless of their socio-demographic characteristics as revealed by Chi-Square test results (Table 5.1). Even though local people were using the wetlands (mean - 9 years) or lived in the area for long (mean -

33.6 years), most were still ignorant of the law meant to protect this prime resource which have innumerable socio-economic and ecological functions (Mitsch and Gosselink 1993; Russi et al 2013). However, given the number of years that people have been using wetlands, it may be important to note that sometimes people may claim ignorance of rules, regulations and laws that they do not agree with, a situation which may mask reality.

Table 5.1: Chi-square test results on association between socio-demographic characteristics of households and their knowledge of wetland law

Attribute	p-value
Gender	0.07
Age	0.27
Education level	0.08
Period of staying in the area	0.31
Period of using the wetland	0.09
Marital status	0.03

A total of 51.2% of the household respondents had attained secondary education compared to 35.1% with primary education and 13% with no formal education. Although most people had formal education, this did not translate to enhancement of people’s knowledge of wetland management legislation since wetland studies were not a specific component of the school curricula. Therefore, the absence of knowledge of wetland law was high in the surveyed wetlands, a situation which threatened effective wetland management as evidenced by resource degradation through practice of legally forbidden activities such as draining and drilling (Figure 5.1).



Figure 5.1: Photographs showing (a) Concrete canals constructed in Dufuya wetland and (b) one of the wells drilled in Madigane wetland

Few people (38.2%; n = 123) were conversant with wetland laws. Interestingly, the majority (95.1%; n = 123) of the surveyed households indicated that it was necessary to possess knowledge on wetland legislation for well co-ordinated wetland protection. A total of 72.3% of 47 household respondents aware of wetland law were married. This may be attributed to the fact that generally married people dominated the surveyed households (71.5%; n = 123). Moreover, married people could have been more conscious of the need to sustainably manage wetlands to cushion their families (with an average size of 5.9 persons) against the effects of increasing drought occurrences diminishing dryland yields (Mugandani et al 2012). The appreciation of wetland law and policies compelled well-informed local people to institute wetland conservation practices.

A review of existing environmental laws and policies revealed that Zimbabwe has no elaborate wetland policy but rather fragmented local policies. The country therefore lacks national guiding principles on ideal wetland management practices (Dale et al 2014). Fragmented local wetland policies, mainly shaped by local tradition, existed at each wetland site. However, differences were noted on local rules and regulations applied at studied sites (Table 5.2). Local policies prohibited destruction of vegetation and animals in preserved wetland sections, an offence punishable by paying a goat to the chief; people were not allowed to drill individual wells but share; only people maintaining fence protecting wetlands were allowed to benefit from the resources; people caught destroying protection fence were expelled from the area by traditional leaders; harvesting of wetland resources was sanctioned by traditional leaders and wetland committees; and the use of ploughs was not allowed where cultivation was done (Table 5.2).

Table 5.2: Local rules and regulations applied in the management of wetlands

Policy	Wetland name					
	Chebvute	Dufuya	Guruguru	Madigane	Tugwi	Zungwi
Prohibit destruction of biodiversity in preserved areas	X	X		X	X	
Traditional leaders approve use of wetlands		X		X		
Wetland committees approve use of wetlands	X	X	X	X	X	X
Use of ploughs prohibited	X			X	X	
Limit number of drilled wells				X		
Wetland benefits reserved to people protecting wetland fence	X	X	X	X	X	X
Expulsion of person(s) vandalizing protection fence		X		X	X	
Expulsion of person(s) extending cultivation into preserved wetland section	X	X		X	X	

The presence of inimitable local policies (that is, impossible to imitate because of being unique to a person or group) made it difficult to synchronise wetland management strategies even in the same district. Each local policy, though known to all local residents, had different levels of success in wetland protection depending on the socio-cultural context of application. Where more local rules and regulations were applied as in the case of Chebvuterambatemwa, Dufuya, Madigane and Tugwi (Table 5.2); wetlands were better conserved through wise use as shown in Chapter 3. The development of a national wetland policy, which recognizes indigenous practices, would therefore encourage the adoption and adaptation of best local management practices in different localities. Absence of national wetland policy is a common handicap to wetland regulation (van Dam et al 2014; Clare et al 2011; Bardecki 1982) as it is difficult if not impossible to review and improve wetland law and synchronise wetland management strategies at local level (Rosolen et al 2014). In contrast, use of a national wetland policy assisted Uganda to transform wetland management initiatives at various scales as a guide to management was explicitly outlined (van Dam et al 2014; Moses 2008). This has made Uganda a pacesetter model of good wetland governance in Africa. Similar observations can be made concerning the South African situation during the past two decades.

5.3.2 *Reasons for communities' poor knowledge on wetland law*

Poor knowledge of wetland legislation was largely attributed to the inadequate dissemination of information on the pertinent legal contextual framework. This contravened provisions of the EMA Act Chapter 20:27 Section 4(1)(b) which clearly states that “all people have the right to access environmental information.” A total of 36.6% of household heads showed that awareness workshops were either absent or rarely conducted by the responsible regulatory institutions. This scenario further contravenes the EMA Chapter 20:27 Section 4(2)(b) which explicitly notes that “environmental education, environmental awareness and the sharing of knowledge and experience must be promoted in order to increase the capacity of communities to address environmental issues and engender values, attitudes, skills and behaviour consistent with environmental management.” Poor environmental education and awareness therefore left the majority of the people with no clue of the existence of wetland law and purpose. The erratic scheduling of workshops further explained why apathy was high (Table 5.3).

Table 5.3: Factors influencing poor wetland law knowledge

Reasons	Frequency (n=123)	Percent
No or few awareness campaigns	45	36.6
Wetland appeared after people had settled	1	0.8
Exclusion of women from community meetings	5	4.1
Wetlands degraded so it's not useful to know the laws	2	1.6
Never got the chance to learn	4	3.3
Missing or not attending education workshops	5	4.1
Not interested to know	12	9.8
Has been away for a long time	1	0.8
Trust advice from local leaders	1	0.8

A total of 9.8% of household heads were not interested to know the provisions of wetland law even when presented with the opportunity to learn. They regarded participation in workshops as a waste of time since no direct livelihood benefits were realised. Instead, they used time meant for workshops to pursue other livelihood options. According to the interviewed DEMAOs and RDCEOs, it would appear that people attended workshops where direct benefits were obtained, for example, food aid distribution. Community meetings held were therefore characterised by poor attendance. The persistence of such attitudes made conservation efforts ineffectual.

Male dominance in social organizations undermined effective dissemination of wetland law information. In most cases, as household leaders, men were at the helm of decision making but they rarely communicated wetland management measures discussed at local meetings (e.g. village) or when invited by external institutions (e.g. EMA, NGOs etc.). Women were often excluded from community meetings due to prevailing patriarchal practices (Table 5.3), although they constitute 48.8% of household heads. Information gleaned from such meetings by men was often not adequately communicated to their female counterparts who were often the most involved in wetland cultivation.

Despite women being the primary users of the environmental resources in comparison to men who were often engaged in non-wetland income related activities such as jobs in the formal and informal sectors had no say on how the resources were managed. Makonese (2008) maintains that women significantly contribute towards sustainable natural resources utilization if they are empowered. Therefore, women's underrepresentation shows the need to target more women in natural resources conservation education as they constitute almost half of the population in surveyed areas and play a pivotal role in conservation (Makonese 2008).

5.3.3 Dissemination of information on wetland law and policy

Various approaches were used to disseminate information about wetland law (Table 5.4). A total of 21.1% of the households sentient of wetland law and policies acquired knowledge through workshops and meetings which were rarely convened by government agencies, political leaders and traditional leaders. 9% of the households became aware of wetland policies through community interactions. Information was normally shared during field operations in wetlands, at funerals, at gatherings to receive relief food aid and even during informal chatting. In some cases, people conducting research in wetlands and through their interaction with wetland users during field surveys and feedback of their findings informed people about the need for sustainable wetland management. The existing formal education system played a marginal role in wetland management information dissemination as discussed earlier. Therefore, there was absence of a well co-ordinated wetland management information dissemination system.

Table 5.4: Methods used to disseminate wetland law information

Method	Frequency (n=123)	Percent
Workshops and meetings	26	21.1
Community interaction	9	7.3
Prosecution	1	0.8
Informed by researchers	2	1.6
Taught in areas people emigrated from	1	0.8
Taught at school	3	2.4
Through own reading	2	1.6
Don't remember	4	3.3

5.3.4 *Strength of wetland law*

Although local people's knowledge of wetland law was poor, the strength of the law was observed from different standpoints. Wetland protection framework provided by the EMA Act (2003) outlined explicit guidelines for users. The use of the permit system according to DEMAOs and RDCEOs, if fully embraced, is likely to instil the spirit of custodianship among local people as user rights and conditions are clearly outlined. Although use of permits was currently absent (since no wetland is utilized with a permit), the following of permit conditions is expected to result in less wetland destruction as people may be conscious of what is required to conserve wetlands and maintain benefits. Moreover, adherence to permit conditions ensures that people are less sceptical of expulsion, a situation which assists in long term planning of livelihood strategies based on the resource. In Canada, it was observed that the issuance of permits changed the way people managed their wetlands, a situation which resulted in more wetlands being protected (Clare et al 2011). This dimension in EMA Act was lacking in the repealed Natural Resources Act (1951) which championed for wetland preservation rather than wise use.

The law's incorporation of local people's ideas in management as revealed 18.7% (n = 123) of the respondents was further hailed for mutual respect sometimes exhibited between officers from local authorities and government institutions and the local people. In the past government officials were hated by local communities and there was no co-operation in wetland management between them. Wetlands were viewed as a menace due to prohibited use and significant loss of livestock through drowning and breeding of disease causing pests or agents. The opening of wetlands to land uses, including crop production, in a way that does not contribute to degradation was applauded as a milestone towards sustainable

utilization of wetlands. According to Mazambani and Dembetembe (2010) only policies and legislation that are sensitive to the environmental and economic rights of communities have a positive impact on natural resources management. In this case, all stakeholders would have a common and shared vision on the resource's health; hence the likelihood of proper engagement and co-operation could be high. Some members of the local community (22%) regarded penalties outlined under environmental law as punitive to the extent that if they were effectively applied, they were bound to reduce wetland degradation.

5.3.5 Obstacles to the implementation of legislation

5.3.5.1 The role of poverty

Widespread poverty compelled local communities to persistently use wetlands without permits in a bid to diversify their livelihood options. This position was shared by 97% of the household respondents who were also unemployed and by all interviewed key informants. There is evidence of decreasing annual rainfall totals between 1979 and 2013 in both Tongogara RDC ($y = -5.5422x + 940.11$; $r^2 = 0.38$) and Vungu RDC ($r^2 = 0.0314$; $y = -5.2576x + 936.69$), although it was statistically insignificant (Marambanyika and Beckedahl in review). The observed rainfall pattern was marked by increasing variability (also noted by Mugandani et al 2012) accompanied by poor agricultural yields from dryland fields which coerced households to turn to wetlands for a living. According to Musamba et al (2011) the conversion of wetlands to other land uses such as crop production was the cheapest way for local people to meet their basic needs. Wetlands as natural resources were therefore a key livelihood asset at the disposal of rural communities to reduce their vulnerability to poverty perpetuated by natural disruption of dryland farming. Households continued to derive livelihood from wetlands since the exit options from poverty were limited (Mwakubo and Obare 2009). Thus, wetland use continued as the rural poor struggle to live (Mangora 2011).

5.3.5.2 Political interference

Political interference resulted in the belittling of wetland law as revealed by 51.3% of households and officers from government agencies. Political leaders pursued populist policies to win the hearts of the electorate thereby condoning illegal use of the resource. Politicians sometimes persuaded regulatory officers to ignore illegal wetland activities with impunity, thereby threatening wetland ecosystems. This result complements that of Mbereko (2008)

who observed that wetland use continued without permits because of the support farmers get from politicians. Politics therefore weakened the capacity of responsible institutions to enforce legal stipulations where political ambitions were under threat (Adekola et al 2012). Although traditional and local political leaders were aware of legislation, since they all participated in environmental workshops, they further abused their power by establishing gardens in wetlands. The majority of the people joined local leaders in fear of losing farming space in the wetlands. However, community leaders are supposed to be role models by demonstrating exemplary behaviour given their influential positions.

5.3.5.3 Inadequate financial and human resources

Regulatory agencies were constrained by inadequate human and financial resources, which made their surveillance very infrequent and at best on ad hoc basis. This result complements earlier findings by Murombedzi (1994) and Magole et al (2010). For instance, each district had one officer responsible for enforcing general environmental law. Therefore, no special focus was given to wetlands. During interviews with DEMAOs, it was also revealed that the EMA had one vehicle shared by all the eight districts in Midlands province. This made enforcement of the law poor resulting in local communities viewing the law as toothless and worth ignoring. The research findings therefore augments the well established position by previous research that wetland laws were not respected due to absence of monitoring (Rosolen et al 2014) and weak enforcement (Dale et al 2014; Morzaria-Luna et al 2014; Zsuffa et al 2014; Adekola et al 2012) and the perceived reasons being lack of government capacity and resources (Clare et al 2011).

5.3.5.4 Inconsistencies in penalties and fines administered in cases of non-compliance

There was no internal harmony within national laws and between by-laws and national law on penalties and fines administered, a situation acknowledged by 34.1% of household respondents and some interviewed key informants. It was noted that diverse penalties were administered by different institutions involved in wetlands governance. For instance, EMA Act Section 113 and S.I. 7 of 2007 had different extent of penalties although they were administered by the same Agency. EMA Act penalties did not exceed Level 8 (US\$500) or maximum of two years in prison or both whereas for S.I. 7 of 2007 fines did not exceed Level 10 (US\$700) or maximum of six months in prison or both. Therefore, EMA Act had a longer period of jail sentence and a lower maximum fine compared to S.I. 7 of 2007 with an inverse

scenario. All fines in Zimbabwe were gazetted by the Ministry of Finance to maintain uniformity and range from Level 1 (US\$5) to 14 (US\$5000).

Penalties for by-laws were far lower than those administered under national law. For instance, maximum fine under by-laws was US\$20 compared to US\$700 for S.I. 7 of 2007. Thus, the impact of the law varied depending on the penalty imposed on an individual. Differences in penalties resulted in people prosecuted under the existing laws to cry foul due to what they misconstrued as favouritism and lack of transparency. Morzaria-Luna et al (2014) also observed that variations in economic penalties for wetland destructions or modifications made law enforcement difficult.

5.3.5.5 Social conflicts

Social conflicts related to wetland use and conservation also undermined implementation of wetland law as revealed by 22.8% of the households. Conflicts culminated in delinquent behaviour (a situation whereby people deliberately break the law), a point raised by traditional and local political leadership who sometimes intervened to resolve the conflicts. Conflicts were caused by competition for benefits (27%), poor leadership (11%), lack of cooperation in wetland management (9%), exclusion of some community members in wetland use (7%), competition for leadership positions where wetland committees exist (2%), prevailing open-access communal tenure system (7%), differences in perceived value of the wetland (21%) and poor organization of management structures where wetlands were under the management of committees (16%). Social conflicts were apparent in Dufuya, Guruguru, Madigane and Zungwi where disagreements on management strategies were responsible for the wetland desiccation due to vandalism of protection fences and encroachment of cultivation by adjacent farmers (Figure 5.2).



Figure 5.2: Evidence of garden being extended and encroaching on Madigane wetland

5.3.5.6 Inconsistent levels of prosecution

The interaction between unlicensed wetland users and regulatory authorities in wetland activities caused local communities to demean enforcement agencies' conservation efforts. Instead of apprehending unlicensed wetland users, EMA officers and RDCEO were sometimes seen interacting and teaching illegal wetland users about wise use, a situation which made local people to view the law as a gimmick. The local people expected regulatory authorities like EMA to descend heavily on illegal wetland users. Such inconsistencies were also noted by Fleischman et al (2014) and Clare et al (2011) who observed that reluctance by regulators to sanction violators of the law resulted in persistent degradation of natural resources. Mutambikwa et al (2001) concluded that in reality wetland legislation was not enforced, hence widespread use of largely unregulated cultivation in vleis of Zimbabwe with potential to cause degradation.

About 34.1% of questionnaire respondents were frustrated by what they perceived as selective application of the law. External development agencies introduced activities in wetlands known by some local people to be prohibited by wetland law without being reprimanded. For instance, donors introduced broad furrows and broad ridges farming system in Guruguru and Zungwi and concrete drains were constructed in Dufuya and Madigane. All these activities contravened EMA Act Chapter 20:27 Section 113(2)(a and b) which prohibits draining and channeling in wetlands. Therefore, sanctioning of externally driven innovations

by local authorities infuriated local people and undermined their zeal to conserve wetlands due to what they perceive as “double-standards”. Therefore observance of wetland law was weakened.

5.3.5.7 Poor knowledge of wetland law

Lack of understanding and appreciation of wetland law by local communities continue to foster poor wetland management. The majority of the households (74%) were not aware of the permitting system and that wetland draining for cultivation was forbidden. Instead they were surprised to be arraigned for such practices. The effect of such ignorance about wetland laws was also pointed out by Clare et al (2011) who stated that ignorance of the law was a common problem which resulted in illegal occupation or filling of wetlands by agricultural communities. Therefore, as long as local communities were not privy to provisions of the law, violations were likely to continue at the expense of wetland existence.

5.3.5.8 Absence of wetland inventory

Lack of a current wetland inventory made implementation and monitoring of wetland law difficult. According to DEMAOs and RDCEOs, their institutions had no database of wetlands as full scale surveys were still to commence due to lack of funding. This result confirms van Dam et al (2014)’s findings that less than 40% of countries which were Ramsar signatories had completed wetland inventories. Absence of knowledge on number and diversity of wetlands significantly compromised management efforts resulting in degradation taking place unnoticed (La Peyre et al 2001). Enforcement of the law therefore became reactive as responsible institutions sometimes responded to reported cases, a position observed by 33.3% of households. Clare et al (2011) also noted that there was a general tendency by government agencies to primarily respond to violations that come to their attention through public complaints or self-reporting.

5.3.5.9 Corruption and nepotism

Corruption and nepotism were revealed by 44.7% of the households as a stumbling block to effective implementation of the wetland law. It was alleged that bribes were sometimes paid to traditional leaders and officers from government agencies by those who wanted to evade prosecution. This left law abiding citizens and the poor with no capacity to pay bribes

disgruntled and not co-operating with environmental agencies in wetland protection. The need to preserve social relations further weakened the ability of traditional leaders and local political leaders to monitor local people's adherence to law. The mere fact that traditional leaders and Ward councillors live with the people meant that they had cordial social relations to maintain beyond natural resources conservation; hence they sometimes turned a blind eye to offences committed by relatives and friends.

5.3.5.10 Lack of complementarity between traditional leaders and government agencies roles

The dual system of wetland governance shaped by government agencies and traditional institutions further magnified problems encountered in wetland management. There was lack of synergies in institutional objectives and efforts. Traditional leaders dominated in wetland resources governance in Zimbabwe. Instead of supervising implementation of environmental law as prescribed under the Traditional leader's Act Chapter 29:17 Section 5(1)(l)(iv), in most cases traditional leaders promoted or ignored use of wetland ecosystems by local communities who thrived to enhance their livelihood options in light of little government support and harsh climatic conditions. Since 53.7% of the households indicated that they religiously follow advice from traditional leaders due to existing social relations and proximity, local people therefore demeaned wetland law as it was viewed to be inconsequential due to poor local monitoring. The problem was further exacerbated by inadequate administration of the law by government agencies.

5.3.5.11 Inconsistent dissemination of provisions of the law and policies

In some cases there was contradictory dissemination of wetland law provisions by government agencies. Officers from the same agency sometimes either encouraged or forbade wetland activities. For instance, at Chebvuterambatemwa, local people complained that at one point officers from EMA and RDC encouraged wise use of the wetland to the extent that Wetland Day commemorations for the province were held at the site in 2011, as the wetland was hailed a symbol of sustainable utilization. However, in 2013, officers from the same agency threatened the same wetland users with expulsion and reminded them that they were illegal users since they did not have permits. This brought confusion to local communities on their status with regards to wetland use and protection. Subsequently, rampant unsustainable activities ensued in the aftermath of the utterances as incentives for wetland protection were

absolved. Moreover, the absence of gazetted by-laws in some districts such as Vungu resulted in officials resorting to threats or unorthodox practices to scare offenders. Their practices were sometimes viewed to be inconsistent with proclamations by other government agencies. This further confused local people on the best practices to institute so as to enhance wise use of wetlands.

5.3.5.12 Exclusion of some community members

Some households (13%) revealed that violations of wetland law were caused by local people excluded from wetland use. Since these people were deprived of wetland benefits, they see no value in protecting the resource. It was realised that where food security projects were implemented in wetlands, non-project members deliberately sabotaged wetland management initiatives. This was a clear testimony and expression of disgruntlement by excluded members who did not accrue any benefits from the resource. Meanwhile, people using wetlands on lease in Madigane ignored conservation practices as they endeavoured to optimize benefits during their tenure. Since ownership of the resource is communal, whereby people have user rights, some people cultivating in wetlands rent out their portions to others at a fee for an agreed period due to limited space.

5.3.5.13 Resistance to change by some community members

Another problem in wetland law administration was the existence of some wetlands use before enactment of the EMA Act in 2003. Interviewed elderly people and 1.3% of household respondents, who were mostly above the age of 50 years, see no value in wetland law as the wetlands were presumed to have been effectively maintained by local tradition. This finding concurs with that of Mharapara (1995) that wetlands were sustainably utilized, including for agriculture, before introduction of legislation. The use of permit system to regulate wetland activities was viewed as a strategy to deprive local people of natural benefits. Mbereko (2008) further revealed that the application process for permits was either expensive (US\$500) or laborious for the rural farmers resulting in very few pursuing the option, hence persistence of illegal cultivation. Therefore, national law was ignored as it was perceived not to be receptive to the needs of the local people and the wetlands. Moreover, current wetland law was enacted when wetlands were already in use by the local people. Thus, interviewed

key informants acknowledged that it was difficult to implement the law in retrospect and inertia persisted.

5.3.5.14 Failure to value wetlands

Failure to value wetland as a resource has been a challenge. Despite wetlands being known for diverse ecosystems services (Russi et al. 2013; Mwakubo and Obare 2009; Maclean et al. 2009), 38.2% of household heads viewed them as a breeding ground for diseases not worth protecting, given the little net benefits, as wetland agriculture was in some cases limited due to local and national restrictions. Traditional leaders also implicated young people as the ones who often displayed the *'I don't care attitude'*, when it comes to wetland protection. Most of them were not allocated portions for cultivation due to limited space in the wetlands. This shows that people value wetlands where they obtain use benefits. Young people were also at loggerheads with traditional leaders for violating customs and taboos associated with wetlands, a situation which threatened cultural services. However, statistical analysis results using Chi-Square test revealed that knowledge of wetland law was lacking across all age groups ($p = 0.27$).

5.3.5.14 General unwillingness to co-operate

Deviant behaviour exhibited by some members of the community was responsible for gross violation of wetland laws. This was observed by 18.4% of households and interviewed Ward councillors. Stubbornness and disobedience led some community members to deliberately embark on forbidden activities such as extension of plots towards the wetland and into the 30 m buffer from the wetland where human activities are prohibited by the Water Act (Figure 3). This practice was responsible for drainage and drying in some sections of the wetlands where cultivation was taking place. Rosolen et al (2014) also identified disobedience, although rare, as a constraint to absolute wetland legislation compliance.

5.3.5.15 The tenure system

The communal tenure system governing ownership and use of wetlands discourages the spirit of stewardship. About 66% of questionnaire respondents indicated that the wetlands belonged to communities. The public nature of wetland ownership resulted in competition for use

rather than conservation (Maclean et al 2009). The use of wetlands as a public good therefore resulted in violations as people had self-assurance that monitoring was difficult and they could not be apprehended. The problem was also observed by Fleischman et al (2014) who indicated that communal natural resources were abused as their use as common property made surveillance difficult.

5.3.5.16 Language barrier

Language barrier was noted by 9.8% of household respondents to be detrimental to effective dissemination of wetland law. During interviews, a RDCEO revealed that local communities were hostile to officers who did not use local language in their deliberations. Failure to use local language was perceived to be a sign of disrespecting and belittling local people. This in turn resulted in local people violating the law in protest as they had a scapegoat that they were not conversant with what was taught.

5.3.5.17 A God-given resource

Wetland law and policies were viewed as inconsequential to wetlands conservation by 8.1% of the surveyed households. Wetlands were perceived to have a self-regulation and protection capacity regardless of human use since they were created by God. This perception explained why there was encroachment into wetlands by farming activities, a position confirmed by the interviewed elderly people. However, previous research confirmed that it was not possible to rely solely on the ability of the wetland to protect itself against human interference (Ma et al 2013). Intervention measures were therefore required to protect these fragile ecosystems, a position which calls for involvement of local people in wetland policy development and implementation.

5.3.6 The way-forward on wetland governance

The research also solicited for information on the preferred approach by local people to sustainably manage wetlands. The majority of the people (54.5%) would be comfortable with the use of national law and by-laws than traditional approach. National laws were largely viewed as non-discriminatory and empowering everyone to act. Statistical analyses results from Chi-Square tests showed a significant association between age ($p = 0.04$), period of

using wetland ($p = 0.00$) and the proposed approach to wetlands governance. Age groups 36-45 and above 65 preferred the traditional approach compared to other age groups. Those who had used wetlands longer (above 10 years) favoured the traditional approach which does not restrict benefits accrued by locals. However, no significant association was established between marital status ($p = 0.61$), gender ($p = 0.50$), education level ($p = 0.18$) and the preferred approach to wetland governance.

The results of this chapter revealed that there is little awareness and poor implementation of wetland-related laws. Poor awareness of wetland-related policies and laws is mainly underlined by limited awareness programmes for the wetland users due to lack of resources on the part of the enforcement agencies. Moreover, the implementation of wetland law is mainly undermined by high incidences of poverty, political interference, in adequate financial and human resources and poor co-ordination of policies for non-compliance cases. However, the majority of the households were prepared to learn about stipulations of the law aimed at safeguarding the fragile wetland ecosystems by promoting wise use, a move which may improve wetland management in the future. This shows that despite lack of legal knowledge, some local people were conscious of the need to conserve wetlands for local benefits. Therefore, the next chapter investigates strategies adopted by local communities to enhance household food security whilst protecting the wetlands despite conservation challenges posed by existing institutional shortcomings and policy implementation constraints.

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Zimbabwe Environmental Management Act 2003

CHAPTER SIX

STRATEGIES TO PROMOTE SUSTAINABLE WETLAND-BASED HOUSEHOLD FOOD SECURITY

6.1 Introduction

Food security exists when all people in a community, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit 1996). Food insecurity is one of the major challenges facing the world today and Zimbabwe is no exception. According to FAO et al. (2014), an estimated 805 million people worldwide were suffering from chronic hunger between 2012 and 2014, and the majority (791 million) were living in developing countries. According to these authors, Sub-Saharan Africa remains the worst affected region with 23.8% of the entire global population in a dire food situation.

In Zimbabwe, about 2.2 million people were food insecure between 2013 and 2014, and 76.8% of these were living in the drier rural provinces (FEWSNET 2014). Given rural farmers' high reliance on rain-fed subsistence agriculture, their food insecurity has been worsened by erratic rainfall (FAO et al. 2014). Trends over the years also show that the majority of Zimbabwe's wet seasons are often punctuated by mid-season droughts, resulting in poor harvests (Gumbo 2006). Multi-decadal rainfall variability further complicated the food security situation of most rural households (Mazvimavi 2010).

Zimbabwe has been experiencing economic challenges which further adversely affected people's capacity to sustain decent lives, including access to food (Sikwila 2013). Climatic constraints and poor economic performance therefore left the majority of subsistence farming families marooned in poverty and hunger (Chifamba 2013; Mabeza and Mawere 2012). As a result, there has been increasing pressure to use wetlands for growing crops in response to changing climatic conditions, increasing population size and food shortages, despite legal restrictions on wetland cultivation (Mabeza and Mawere 2012; Chifamba 2013; Hove and Chapungu 2013; Zinhiva et al. 2014).

Wetland cultivation is not unique to Zimbabwe, as millions of poor people's livelihoods in sub-Saharan Africa directly depend on wetlands (Rebelo et al. 2010; van Dam et al. 2013; IWMI 2014), which are regarded as the most productive ecosystems (Russi et al. 2013). Wetlands provide diverse ecosystem services, including food, medicinal plants, forest products, groundwater recharge, climate regulation, water purification, nutrition cycling, flow regulation, livestock grazing, food production among others (Galbraith et al. 2005; IWMI

2014). Directly harvested wetland products and indirect services contribute to household food security and income generation (Sakané et al. 2013). Therefore, wetland agriculture and products act as safety net for agriculture-based rural livelihoods (Chifamba 2013; IWMI 2014).

However, wetland agriculture is considered to be the most significant threat to wetland ecology (Hassan and Pantaleo 2009; Rebelo et al. 2010; IWMI 2014). The transformation of wetlands for subsistence farming was identified as the principal cause of wetland degradation in sub-Saharan Africa (Turyahabwe et al. 2013a) and Zimbabwe (Hove and Chapungu 2013). Wetland degradation and loss is attributed to a large range of agricultural activities, such as livestock grazing, watering of livestock, draining for cultivation, abstraction and diversion of water for irrigation, occasional application of fertilizers and pesticides; fisheries and harvesting of wetland products (Finlayson and Rea 1999).

Some established effects of wetland agriculture are conversion of vegetation from native to alien and draining, loss of seasonal wetlands due to changed hydrologic regime, loss of wetland function, due to salinization, sediment deposition, erosion, eutrophication, water withdrawal and pollution from use of pesticides and other chemicals (Galbraith et al. 2005). The degradation of wetlands thus threatens not only the ecology, but also the livelihoods of local people dependent on the resource (Turyahabwe et al. 2013b). According to Verhoeven and Setter (2010) from a sustainability point of view, wetland cultivation should be strongly discouraged as it also threatens the availability of other ecosystem services. However, Rebelo et al. (2010) argued that the basis for suggesting non-wetland cultivation was weak in sub-Saharan Africa, as evidence of sustainable use was available in some areas.

The search for solutions to sustainably utilize wetland resources remains a priority in developing countries where community dependence on natural resources is high. However, this task is extremely difficult and frustrating because of the competing divergent but important goals of food security, poverty alleviation and conservation (Chifamba 2013; Ndiweni and Gwate 2014). Natural resource planners and policy makers often find themselves in a dilemma of trying to balance protection of wetlands and threats to agriculture, as the objectives of these two aspects are not always congruent, especially where livelihood options are lacking (Rebelo et al. 2010; IWMI 2014). Little researched information

is available on the contribution of wetlands to household food security when compared to their environmental importance in developing countries (Turyahabwe et al. 2013a). Thus, it is pertinent to find a strategy to improve complementarity between food security and wetland sustainability as information on the interlinkages is largely lacking (Hassan and Pantaleo 2009).

In Zimbabwe, illegal wetland cultivation by rural households has been persisting regardless of the existence of the law restricting this activity since 2003. This policy position was influenced and sustained by numerous researchers who attributed wetland loss to cultivation (e.g. Whitlow 1989; Mutyavaviri 2006). However, there is urgent need to find a “win-win scenario” of balancing the benefits of use to both wetlands and community livelihood, since human benefits invariably depend on wetland condition. This makes it imperative to understand how communal households are sustaining wetland cultivation and protection in light of espoused institutional, legal and policy constraints. An evaluation of such feasibility to wetland use is important since unsustainable wetland cultivation is commonly known to cause wetland loss and to limit essential food security options in the long term to dependent communities (Verhoeven and Setter 2010; Wood et al. 2002), yet isolated cases of wetland benefitting have also been reported (Kotze 2010; Marambanyika et al. 2012).

The present study investigates the contribution of wetlands to household food security and the local strategies in place to prevent or mitigate wetland degradation from cultivation and other food security related activities in light of national policy restrictions on their use. Therefore, the outcome of this research is intended to inform policy on possible strategies to promote wise use of wetlands as expected under the provisions of the Ramsar convention which the country joined in May 2013. According to Rebelo et al. (2010) one major constraint to sustainable use of wetlands for food security is lack of information for natural resources planners and managers on benefits and techniques that can be used to achieve sustainable use.

6.2 Materials and Methods

6.2.1 Field data collection

Field data were collected during the dry season, between August and October 2014, a period when wetland cropping was active. Before carrying out field surveys on the six selected wetlands, ethical clearance was sought and granted by the Research Ethics Committee, University of KwaZulu Natal (Reference: HSS/0735/014D). This was meant to ensure that there would be no violation of research ethics principles, including participants' fundamental rights, such as confidentiality, anonymity and consent to participate.

For each case study, information was obtained, using a detailed household questionnaire, key informant interviews, direct observations and document review. A total of 116 smallholder families, settled in 36 villages adjacent to wetlands (Table 6.1), were randomly selected following random number tables (Dettori 2010), to capture information on wetland contribution to household food security. Only households which were actively involved in utilization (mainly those with cultivation plots) were purposively chosen to form the sampling frame for questionnaires. In Guruguru and Zungwi, former wetland farmers were selected since crop farming was not practiced during the time the survey was conducted. The database of wetland users in each area was obtained from wetland committees elected by the community to co-ordinate utilization and conservation activities.

Table 6.1: Sampling sites and sample size for questionnaire survey

Wetland name	Names of villages around the wetlands	Total number of households using wetland	Sample size
Dufuya	Dhongi, Matiye, Mbizo, Mbiwa, Philip, Sogwala	99	25
Madigane	Madigane, Mulaga, Ndabeni, Ndandani, Skupa	104	26
Tugwi	Chitora, Rio 1, Rio 2 and Zvavahera	69	17
Guruguru	Jekenyekwa, Kanyanyi, Matiki, Marozva, Mujahu	36	9
Chebvuterambatemwa	Chabvepi, Hlupo, Manyunga, Mudhonga, Mukwekwe, Musindo, Nyika, Ruzive, Ziyani'a	87	22
Zungwi	Gandiwa, Isaya, Jumo, Mapira, Shamira, Sikovo, Tachiona, Urayayi, Virimai	68	17
Total		463	116

Questionnaires were completed by household heads or in their absence the eldest and knowledgeable person present. A pilot study was conducted to pre-test the questionnaire at a different wetland with similar land use types and population attributes, especially the two languages used in the study sites. The pilot study allowed the interviewers to gain familiarity with the instrument as well as providing them with an opportunity to apply and review the instrument. This was achieved by assessing whether respondents understood the questions and identifying any problems encountered in providing answers. After the pilot study, the questionnaire was adjusted to match the specific conditions of the study sites. Questionnaires were drafted in English and translated into local languages (Shona and Ndebele) for easy interpretation by household participants. Research assistants were trained to probe for more detailed information when appropriate during the survey.

The household survey sought to provide information on wetland conservation strategies and their contribution to household food security and income generation. Questions in the first section of the questionnaire were specifically designed to determine the socio-economic attributes of household head (gender, age, education level, marital status, wetland farming experience), family structure (size and dependency ratio), mode of land acquisition in the wetland and distance from homestead to wetland field. The other sections captured information on household food security status, determinants of households' vulnerability to hunger, the resources directly and indirectly obtained from wetlands (for food security), land use types, the primary use of wetland products, access to market, measures to prevent or mitigate wetland degradation including governance structures, and local perceptions on wetland biophysical conditions.

Key informant interviews were conducted with officials from Agricultural, Technical and Extension Services (Agritex), the Environmental Management Agency (EMA), Shurugwi partners, leadership of wetland committees and local leadership (Ward councillors and Village heads). All interviews were conducted face-to-face following a prepared template using open-ended questions. The necessary logistical planning and arrangements were done in advance. Interviews were carried out at a place and time suggested by the interviewee for his/her convenience. With the consent of the interviewee, interviews were tape-recorded and notes were taken at the same time to capture important material to inform data analysis.

Interviews captured information on food security status of the local people, factors determining household vulnerability, the goods and services obtained from wetlands and their contribution to household food security, proportion of cultivated wetland area in relation to wetland size, conservation measures put in place by each community and the trade-offs between food security provision and wetland conservation objectives. Direct observations were carried out through transect walks to assess the status of wetlands and the types of land use. Recording of observed attributes of interest was guided by a checklist to ensure consistency in carrying out the task across the surveyed wetlands. Agritex and wetland committees' records were analysed to provide information on crop yield data for crops cultivated in wetlands.

6.2.2 Data analysis

Quantitative data generated through the household questionnaire survey were coded and analysed in Statistical Package for Social Scientists (SPSS) Version 16.0 for Windows, at 95% confidence level. Statistical analysis of variance was performed on quantitative variables and combinations of some of these variables, to establish differences in household attributes (household size, dependency ratio, plot size), and household food security status (number of meals, and estimated level of food and income from wetland). Tukey's or Games-Howell post hoc test was performed to separate means where differences between wetlands occurred during analysis of variance. Games Howell post hoc test was performed where the data did not meet the homogeneity of variances assumption, e.g. on wetland income and plot sizes.

Kruskal-Wallis test was used to determine differences in household food security status and differences on perceptions of future wetland conditions, since the data was measured on an ordinal scale. A non-parametric Wilcoxon Signed Ranks test was used to explain variations in household perceptions of duration of moist conditions before and after the introduction of cultivation in wetlands. Spearman correlation coefficient was used to show the relationship between wetland income and number of meals per household. Wetland income was calculated based on prevailing market prices. Descriptive statistics were used to show frequencies in percentages on household responses for selected variables. Error bars were used to show differences in use of wetland goods. Audio-taped key informant interviews were first transcribed verbatim and analyzed through thematic analysis (Braun and Clarke

2006). Emerging themes were presented in prose to capture respondents' views on household food security in relation to wetland use and the conservation measures adopted.

6.3 Aspects of sustainability and food security

6.3.1 Socio-economic characteristics and food security status of households

The average household size was 5.9 persons, but significant differences were noted ($p = 0.010$) between the wetlands studied, in particular, Guruguru and Tugwi ($p = 0.04$), and Tugwi and Zungwi ($p = 0.04$). Guruguru and Zungwi had the highest average number of persons per household (7.2) compared to Tugwi with the lowest (4.2). There were no cases of child-headed families and 17.6% of households were headed by elderly people (above 65 years). There was almost a balance between male-headed and female-headed households. 51.2% of households were male-headed compared to 48.8% female-headed. The majority of household respondents (75.9%) were married. Only 12.8% of heads had no formal education.

Most of household heads (91.9%) were not formally employed. The average number of economically inactive persons per household was 4.1, representing 69.5% of the total household population. The dependency ratio did not vary significantly between wetlands ($p = 0.59$). It also did not vary with the age of household head ($p = 0.55$). Most of the farming plots (82.2%) in wetlands were allocated by local leaders (Village heads, Ward councillors and Wetland committees). The remaining households inherited (11.1%), purchased (3.3%) or rent (4.4%) their plots. On average homesteads were found within a distance of 1.2 km from the wetland boundary, a distance can foot for approximately 23 minutes. The existence of the local community was on average 33.54 years and did not vary between sites ($p = 0.23$).

About 59.6% of households were food secure over the past 10 years, implying that some 40% were not. This period coincides with the average number of years (8.8 years) households have been utilizing wetlands. However, variations existed ($p = 0.00$) in period of wetland use and were more evident between Madigane and Guruguru ($p = 0.01$) and Madigane and Tugwi ($p = 0.02$). Households in Madigane had the longest period of wetland use (13.9 years) and Tugwi had the least (4 years). Most of the current wetland activities were initiated by NGOs. Twenty six percent (26%) and 17.1% of household respondents reported transitory and chronic food insecurity respectively. Generally, there were statistically significant differences

in food security status of households adjacent to different wetlands ($p = 0.00$). Variations were clearly visible between Madigane and Guruguru ($p = 0.03$) and Madigane and Zungwi ($p = 0.00$). Almost all households in the food insecurity categories were found at Guruguru and Zungwi where wetland degradation was observed. Most (79.2%) households' food situation was stable at Dufuya, Madigane and Tugwi.

Food security did not vary with household size ($p = 0.27$), dependency ratio ($p = 0.26$), marital status ($p = 0.48$), gender ($p = 0.36$) and education level ($p = 0.47$) of household head. The average number of meals per household was 2.59 per day although variations were observed between wetland communities ($p = 0.00$). Disparities were significant between Dufuya and Guruguru ($p = 0.03$), Dufuya and Zungwi ($p = 0.02$), Madigane and Guruguru ($p = 0.04$) and Madigane and Zungwi ($p = 0.02$). Residents in Dufuya and Madigane had on average more daily meals (≥ 3) than those surrounding Guruguru and Zungwi (≤ 2). Other livelihood sources influencing household food security include remittances from family members working in urban areas or outside the country (9.5%), temporary jobs or contract work (19.8%), formal employment (7.8%), gold panning (2.6%), own business (3.5%) and dryland crop yield (56.9%).

6.3.2 The contribution of wetlands to household food security

On average, households estimated that 48.5% of their food needs were directly sustained by wetland cultivation, practised on 53.4% of the total wetland area. Other livelihood activities include livestock production, aquaculture and apiculture. For instance, a livestock watering point was constructed in the Dufuya wetland. Livestock is a source of rural communities' wealth and farmers sell them to buy food during drought periods. A few households (12.1%) in Dufuya were involved in fishing, in small dams excavated in the lower section of the wetland. Some households (13.6%) were involved in beekeeping at Chebvuterambatemwa wetland. At Tugwi, the construction of beehives for honey production was almost complete, with all participating households likely to benefit. However, the extent of wetland contribution to household food security vary between the surveyed communities ($p = 0.00$). It was very low in degraded Guruguru and Zungwi wetlands compared to other areas (Table 6.2).

Table 6.2: Estimated percentage of household food directly obtained from wetlands

Wetland Name	Number of households interviewed	% of food obtained from wetland	Standard Deviation
Dufuya	25	69.0	22.7
Madigane	26	80.2	19.2
Chebvuterambatemwa	22	55.6	21.2
Zungwi	17	11.4	15.5
Guruguru	9	0.0	0.0
Tugwi	17	63.6	22.5
Total	116	48.5	35.2

6.3.3 Wetland products contributing to household food security

Wetland products contributing to food security as indicated by household respondents were water (100%), fish (0.9%), thatch grass (4.3%), reeds (1.7%), worms for fishing in surrounding water bodies (6%), fodder for domesticated animals (e.g. rabbits) (1.7%), honey (5.2%), wild fruits (2.6%), wild animals for meat (bush pig (*Potamochoerus larvatus*), amavondo, duiker (*Cephalophus natalensis*) (4.3%) and wild vegetables e.g. *chiveve* (0.9%). Water is used for domestic purposes (cooking, drinking, cleaning, washing etc.), livestock watering, crop irrigation and brick moulding.

Vegetables are common in all areas, except Guruguru and Zungwi. Vegetables grown in wetlands include kale (*Tronchuda portuguesa*), rape (*Brassica napus*), tomatoes (*Lycopersicon esculentum*), carrots (*Daucus carota*), cabbages (*Brassica oleracea var. capitata*) and onions (*Allium cepa*). Other food crops grown are sweet potatoes/*ipomoea batatas* (19.8%), maize/*zea mays* (82.8%), beans (34.5%), peas (9.5%), butternuts/*Cucurbita sp.* (6%), bananas (7.8%) and sugarcane/*Saccharum officinale* (2.6%) (Table 6.3). Fruit trees include guava, peaches and mango. On average 67% of vegetables and 3.4% of maize is sold in Chebvuterambatemwa, Dufuya, Madigane and Tugwi. The low percentage of maize sold was attributed to direct use of maize to prepare daily meals. Most (78.6%) of the revenue generated was used to purchase foodstuffs to supplement and diversify daily diets. The remainder was used to fulfil other basic needs such as clothing and paying fees for school-going pupils.

Table 6.3: Estimated average annual crop production levels (in kg) per household

Crop variety	Chebvuterambatemwa	Dufuya	Madigane	Tugwi
Beans	65.8	0	5	52.9
Butternuts	0	13.2	21.3	127.1
Cabbage	0	82	55	29.6
Carrots	0	99	214	127.1
Kale	0	3114	4318	0
Cucumber	0	6	17	0
Maize	145	45	70	0
Okra	0	22	176	101.6
Onion	0	109	299	38.1
Rape	0	0	388	4065.9
Sweet potatoes	26	0	0	0
Tomato	0	222	166	0
Wheat	62.2	0	0	0

Note that statistics for Guruguru and Zungwi are not presented as the wetlands were not productive during the survey period.

6.3.4 *The contribution of wetlands to household income*

Household income is generated from crop products, harvested natural products (e.g. herbs) or by-products from wetland natural resources (e.g. reeds baskets and mats) (Fig. 2). Wetland farmers also sell value added products like ‘*mufushwa*’ (dried vegetables) at an average of \$36 per bag. Most income (approximately 95%) is generated from agricultural produce than harvested natural products. The average annual household cash income from wetlands was US\$527.13. Therefore, wetlands contribute 64.7% of average household total cash income (US\$815.33) per year. However, the level of cash income vary ($p = 0.00$), especially between Madigane and Chebvuterambatemwa ($p = 0.02$) and Madigane and Tugwi ($p = 0.01$). Madigane households had the highest mean annual cash income (\$1234.85) and Tugwi had the least (\$135.64) followed by Chebvuterambatemwa (\$181.96). It was observed that where cash income was low, it did not necessarily mean that wetland yield was poor but a significant amount was directly consumed, for example, at Chebvuterambatemwa (Figure 6.1). In Dufuya and Madigane, vegetables with multiple harvests and high market turnover were grown; hence they generate more household revenue. Moreover, these two wetlands were closer to a large market, City of Gweru. In Guruguru and Zungwi, maize and wheat are no longer grown for commercial purpose.

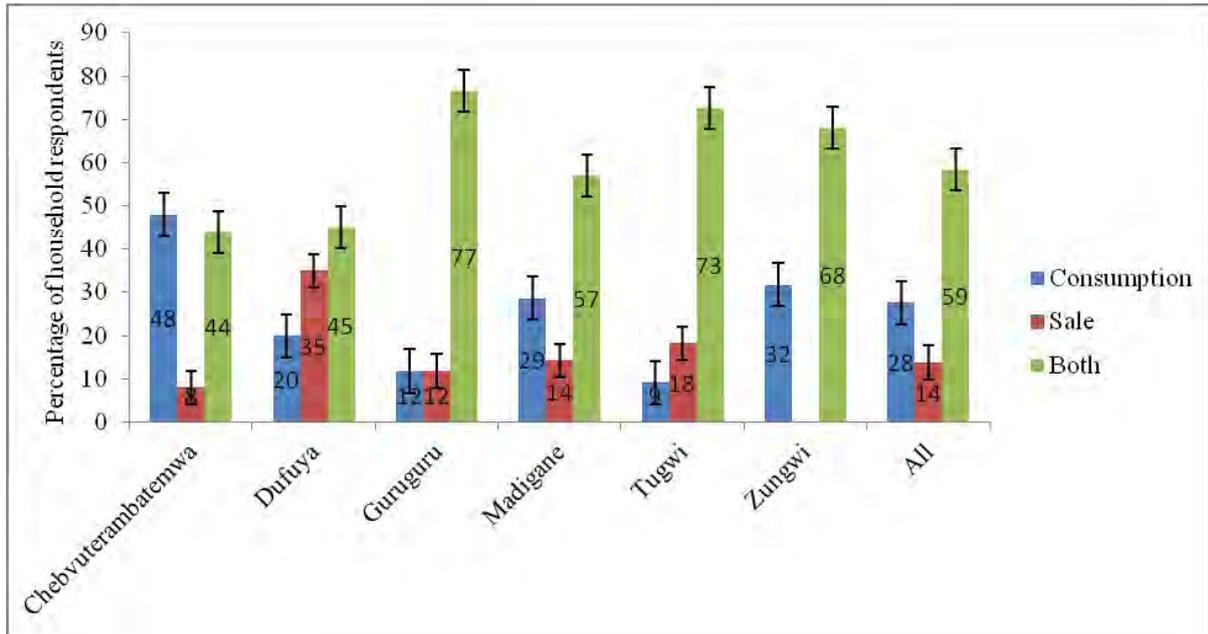


Figure 6.1: The use of wetland products by households. Note that statistics for Guruguru and Zungwi show estimated previous use of wetland products

Wetland income was high where individual farm sizes were comparably large. For instance, in Madigane, the largest farms were 0.08 ha in size. Individual plot sizes differed significantly ($p = 0.01$); especially between Madigane (mean 0.03 ha) and Chevuterambatemwa ($p = 0.02$) and Tugwi ($p = 0.03$). The average wetland farm size was 0.03 ha, and they ranged from 0.016 ha to 0.08 ha. In Chevuterambatemwa and Tugwi, the average farm size was 0.02 ha. However, plot size did not vary with mode of land acquisition ($p = 0.09$), education level ($p = 0.06$), marital status ($p = 0.44$) and age group of head ($p = 0.26$). In Guruguru and Zungwi farming was done under co-operatives; hence there were no individual plots. Spearman correlation coefficient results showed that there was a significant positive relationship between wetland income and number of meals ($r = 0.20$; $p = 0.03$). All things being equal, this suggests that households with more wetland income had many meals. The contribution of wetlands to household income is also supported by the work of Rebelo et al (2010) who indicated that 80% of poor households' cash income was from wetlands in the Kilombero valley.

Most household heads (49.1%) indicated that cash income generated by farmers can be increased without expanding cultivation space, if the marketing system improves. Farmers currently sell their products at open markets, usually unregulated and vulnerable to unpredictable prices. This has been affecting their profit margins. In worst cases, farmers fail

to recover transport costs after selling their produce due to low prices. In order to deal with marketing challenges, households at Tugwi formed a Horticulture Marketing sub-committee which conduct market surveys and negotiate supply contracts. This has resulted in farmers gaining access to stable high value markets such as Spar and Servcor. For instance, Midlands Spar purchases a vegetable bundle at US\$0.35 compared to US\$0.20 at informal market. Since farmers transport their own produce to the market, transport problems and the poor road network also affect effective marketing of wetland produce.

6.3.5 Causes of household dependency on wetlands for food security

A combination of socio-economic and natural factors affects the household food security situation of the adjacent wetland communities. Given that rain-fed dryland farming is the mainstay of rural livelihoods, 28.5% of household heads revealed that crop production on dry lands was threatened by soil erosion and declining soil fertility. Key informants attributed this problem to overuse of soils due to limited farming space, land fragmentation as a result of increasing population size (Table 2.4) and poor soil conservation strategies. Further to this, crop production was susceptible to increasing rainfall variability which made effective agricultural planning difficult. Most households (67.2%) revealed that agricultural seasons were marked by late start of rains, early cessation or poor rainfall distribution, thereby disrupting farming trends local people were accustomed to. This resulted in recurring poor harvests forcing people to look for optional survival strategies such as wetland farming. The problem of climatic variability, with irregular precipitation, was also widely observed in Zimbabwe (Mazvimavi 2010; Mugandani et al. 2012). Poor harvests from dry land farms due to the prevailing semi-arid conditions further resulted in high local market prices for the key staple food, maize. This subsequently eroded revenue at the disposal of people as they buy limited food at inflated prices or resort to purchase of food in distant locations; thereby incurring transport costs.

Twenty-two percent of households also indicated that, even in a good rainfall season, dry land crop yields remained low due to lack of or inadequate access to critical agricultural inputs, such as maize seeds and inorganic fertilizers. Most of the households relied on government free seed packs (composed of 10 kg maize seed, 50 kg ammonium nitrate and 50 kg compound D) distributed late under the Presidential Scheme. Normally farmers receive the inputs at the middle or towards the end of the farming season, making their direct

contribution to dry land food production limited. These inputs are then often used in wetlands where moist conditions will be available. Sometimes high market prices as a result of insufficient supply of seeds and agro-chemicals by manufacturers made their accessibility by cash-strapped subsistence farmers difficult. This perpetuates a vicious cycle of food insecurity and poverty among local households dependent on dry land farming.

The reduction in number of NGOs providing agricultural assistance and food (as noted by 10.3% of households and some key informants) also negatively affect household food availability and access. This was necessitated by increasing political interference in NGOs' operations in the post-2000 period. Prior to this period, NGOs were widely involved in relief or project food aid programmes. Under project food aid, NGOs implemented nutrition gardens outside wetlands and promoted adoption of drought tolerant crop varieties and goat production projects. Therefore, in light of the abovementioned challenges, households and key informants mentioned that wetlands ensured improved food security most of the time, including drought periods. Moreover, 76.7% of households revealed that their participation in wetland-based food security projects was influenced by NGOs providing funding and expertise.

6.3.6 Community perceptions on the impact of human activities in the wetlands

Although 76.7% of households at Chebvuterambatemwa, Dufuya, Madigane and Tugwi suggested that wetland hydrology was not affected by food security activities, all household respondents at Guruguru and Tugwi revealed that hydrological conditions changed since the introduction of broad ridge and broad furrow (BR/BF) cultivation technology. A comparison of household perceptions on the duration of wet conditions before and after introduction of this intensive cultivation technology revealed a significant decrease in the duration of wetness ($Z = -0.55$; $p = 0.00$) at Guruguru and Tugwi. Wet conditions previously lasted for almost a year but now barely last for 2 months after the termination of the rain season. Other observed types of degradation in all wetlands include soil erosion (4.3%), chemical soil deterioration evidenced by increased application of fertilizers (37.1%), decline in water quality (2.6%) and reduction in natural vegetation cover (28.5%).

Soil erosion by water was influenced by tillage practices, such as use of ox-drawn ploughs which loosened the topsoil. This tillage system was observed in Madigane where plot sizes

were fairly large; making it difficult for households to adequately prepare land for cultivation using hand tools. Loss of soil nutrients resulted in application of organic and inorganic fertilizers by 88.8% of households. At Guruguru, households observed that water colour turned yellowish-reddish during the period of intensive farming under BR/BF. Kruskal-Wallis test results show significant differences in household perceptions ($p = 0.00$) of future projection of wetland hydrology in light of current land use. Farmers at Chebvuterambatemwa, Dufuya, Madigane and Tugwi anticipate no change whereas at Guruguru and Zungwi total loss is predicted if no rehabilitation is done.

6.3.7 Community contribution towards the success of wetland-based food security projects

The communities are involved in fencing of wetlands for both food production and conservation. For instance, farmers at Tugwi provided fencing poles at a cost of US\$1620 and two bags of cement at a cost of US\$26. In Dufuya, Chebvuterambatemwa and Madigane, local residents who were allocated farming plots in the wetland provide labour for conservation activities, such as fence maintenance. The utilization of plots for food production by households acts as an incentive to promote maintenance of a protective fence. During the time when wetland cultivation was prohibited, the fence was vandalised. Beneficiaries now monitor vandalism to the extent that removal of the fence has ceased; hence no more cattle trampling commonly blamed for wetland degradation (Dahwa et al. 2013) and loss of crops. Plot-holders also regularly replace rotten wood poles supporting the fence.

Local people contribute mealie-meal, vegetables, milk, fresh maize and firewood for environmental education and gender mainstreaming workshops. In these workshops, local people are trained on wetland management, project management, participatory land use management, organic farming, integrated pest management, vegetable production, fruit orchard and nurseries development, beekeeping, fish farming and market linkages for horticultural produce. All these activities are meant to enhance sustainable utilization of wetlands by local communities, including ensuring participation of women often marginalized in development projects (Makonese 2008). At least 50% of participants in these workshops were women. Where training workshops were often conducted at Dufuya and

Tugwi, knowledge and skills acquired contributed to improved crop production and better wetland conservation.

A committee was elected at each wetland to oversee wetland management. The committee monitors fence protection, degrading activities (such as use of ox-drawn ploughs and extension of plots in the wetland) and crop theft. However, at Tugwi, in addition to the main wetland group committee, sub-committees such as horticultural marketing, organic lead farmers and wetland scouts existed. Wetland scouts monitors fireguards, cleanliness and hygiene in the gardens in order to uphold organic farming standards set by Zimbabwe Organic Producers and Promoters Association (ZOPPA). A horticultural marketing sub-committee conducts market surveys to establish market requirements in terms of crop varieties, quality and prices. This has improved net economic gains, as supply contracts were secured with big commercial entities such as Spar, Servcor, Unki Mines, Chicken Slice, Exquisite Café, FC Platinum, to name a few.

The farmers formulated resource management policies particularly for the wetlands (water source) and soil conservation. Techniques such as minimum tillage, contours, infiltration pits, crop rotation, intercropping, green manure, animal manure and mulching were adopted. The level of adoption and implementation of conservation practices by 81.1% of households in Chebputerambatemwa, Dufuya, Madigane and Tugwi, vary from each wetland. Basin tillage system was introduced in Chebputerambatemwa and Madigane by 41.7% of farmers to manage soil erosion, and the rate of water abstraction and wastage during crop irrigation.

The use of plant and animal manure is promoted in all wetlands. Other than replenishing soil nutrients, the strategy is viewed as a low cost source of fertilizer which also protects the ecosystem. According to Koelsch and Wiederholt (2011) environmental benefits of organic manure include increased soil carbon and reduced atmospheric carbon levels, reduced soil erosion and run-off and reduced nitrate leaching. Cultivation projects in Guruguru and Zungwi which relied on inorganic fertilizers collapsed as farmers could not sustain the production costs. Composting using crop residue and weeds was also adopted as a low cost strategy to replenish soil nutrients by 38.5% of farmers in Madigane. Mulching was introduced by 21.1% of the farmers in Chebputerambatemwa, Dufuya, Madigane and Tugwi because of its dual role of reducing evaporation and replenishing soil nutrients. In Tugwi,

farmers were encouraged to minimize burning of crop residue. Crop rotation as a strategy to maintain soil nutrients and break pest cycles was adopted by 39.7% of all household respondents.

In Tugwi, since gardens are certified by ZOPPA, farmers adhere to internal organic standards and sanctions so as to maintain wetland farming benefits and protect its ecological conditions (Appendix 6.1). For instance, four farmers were expelled for violating these standards. The penalties are assisting to instil a spirit of stewardship among wetland users. Market sheds were constructed to minimise post-harvest losses before transporting wetland produce to the market. Before adoption of this strategy, the quality of fresh farm produce was depreciated mainly by heat and pests. The sheds assist to mitigate the problem of post harvest losses, observed by World Bank (2011), to account for a total of 20 – 40% of all crop losses in sub Saharan African countries. Therefore, the sheds are assisting to improve income by reducing post harvest losses. The market sheds also enable the farmers to sell their produce to locals; thereby improving their income.

The internal organic standards at Tugwi ensure that the soil and water sources are not polluted by any means and any offender is sanctioned, as penalties are clearly defined for each offence. For instance, the use of synthetic chemical fertilizers, pesticides and herbicides is prohibited and any form of violation will lead to expulsion from wetland use. In Tugwi, an Organic Lead Farmers committee (composed of 2 females and 2 males) was trained by ZOPPA to train other farmers on organic farming practices. As a result, the gardens are certified to organic farming which promotes quality farm produce in line with ISO 22 000 food safety standards. It is mandatory for households involved in organic farming to ensure that there is family involvement in the application of sustainable land management principles meant to increase land productivity, improve livelihoods and ecosystem protection. Family involvement assists in generational transfer of knowledge on wise use of wetlands.

Seed bank development schemes were adopted at Tugwi to promote traditional vegetable varieties, such as spider plant (*Cleome gynandra*), locally known as 'nyeve', demanded by some corporate entities in the food business. This strategy is also intended to place the smallholder farmers in a position of being able to eventually function as agro dealers supplying inputs to the district and beyond thereby expanding their enterprise. Therefore, the

diversification of farmers' portfolio would enhance income, which can act as an incentive to attainment of sustainable land management goals (Liniger et al. 2011). Moreover, seeds from the bank are cheap compared to tested seeds from agro dealers and are compatible with principles of organic farming. Thus, local production of seeds is another low cost strategy of input supply.

Low-cost and environmentally friendly methods for pest management have been adopted. The farmers (22.4%) control/spray pests such as aphids using a substance made from *lantana camara* residue. *Lantana camara* is an invasive species found in the area surrounding the wetland. Vegetation strips are left between plots to mitigate soil erosion in Dufuya. Sand traps were established at Chebvuterambatemwa to prevent excessive sediment load from the catchment. Moreover, 23.5% of households at Tugwi established water harvesting structures like infiltration pits around their gardens so as to manage surface run-off and erosion. By adopting low-cost and environmentally friendly technologies, the communities prevented or mitigated wetland degradation; thereby promoting sustainable food security.

6.3.8 How does wetland cultivation continue in light of legal restrictions?

Under the Zimbabwean environmental law, Environmental Management Act (EMA Act) Chapter 20:27 subsection 113, the use of wetland for cultivation without a permit is prohibited. However, all the wetlands studied were cultivated without permits. The question remains, how do local communities sustain wetland agriculture without complying with this legal requirement? Although 65.5% of the households were not aware of this legal requirement, all households revealed that pressing food shortages due to climatic constraints and economic meltdown compel them to engage in wetland cultivation. EMA officers confirmed that it was a struggle to prohibit wetland cultivation given the extent of households' livelihood dependence on wetlands as a result of existing economic and climatic constraints.

Local communities adopted a number of strategies to ensure sustainable use of wetlands in order to minimize attrition with law enforcement agencies. Despite poor enforcement (as confirmed by 57.8% of household respondents) and widespread lack of knowledge on wetland law by local people, communities implement conservation farming techniques as discussed earlier to promote wise use of wetlands. This has resulted in environmental

agencies sympathizing with local communities as revealed by 29.3% of household respondents and EMA officers. As a result, environmental agencies only expel farmers engaging in unsustainable cultivation practices such as use of ox-drawn ploughs which exacerbate soil erosion, extending farming plots into the wetland beyond set demarcations and drilling of several wells across the wetland landscape. The attitude of environmental agencies compelled households to be environmentally conscious when using wetlands for food production since eviction is inevitable for degrading activities.

The communities formed committees to assist in the management of wetlands. The committees convene meetings to facilitate engagement between local people and other institutions involved in wetland management such as Agritex, EMA and NGOs. For instance, Agritex provide training to farmers on crop production, soil and water conservation. Therefore, institutional interaction promoted dissemination of information on participatory sustainable wetland management. The committees also enforce expulsions of farmers whose practices degrade wetlands. The formation of wetland committees therefore assisted local people to get buy-in of their activities by law enforcement agencies as reported by 19.2% of surveyed households. However, 14.9% of households in Chebvuterambatemwa and Madigane reported that local residents take advantage of few law enforcement agencies to underreport or not report wetland degradation in fear of expulsions. Political interference also weakened the proper function of enforcement agencies at Madigane where the Ward councillor is involved.

6.4 Discussion

Ecosystem services provided by wetlands help to stabilize all dimensions of food security; availability, access and utilization, for communities adjacent to surveyed wetlands. Wetlands provide conditions that enable provision of a wider range of crops (Table 6.3). Although the nutritional composition and quality of food was not measured, the range of wetland food produce suggests diversified household diets, possibly contributing to healthy lives. The majority of household heads were not formally employed and household dependency ratio was high, as 69.5% of the total household population fall in the economically inactive category. These household attributes together with increasing climatic variability and declining fertility and erosion of arable land may explain why household dependency on wetlands for food security was high (Table 6.2). Contrary to observations by Rebelo et al.

(2010) in Tanzania that wetlands were used as a coping strategy in times of food scarcity; the results of this study show that the resource is an indispensable part of communities' livelihoods. This finding is similar to that of Turyahabwe (2013a) who observed that wetlands are the basis of household food security in Uganda.

Although the majority of wetland dependent households were food secure, consuming approximately 3 meals a day, the food security status of households varies depending on the duration of wetland use, plot size and the state of the wetland conditions. Households got more than half of their food from undegraded wetlands (Table 6.2). People living adjacent to Madigane obtain the highest amount of food (80%) and income. This was attributed to large plot sizes (above the average size of 0.03 ha) and longer period of use (13.9 years) compared to the average 8.8 years. This may suggest that farming experience and large plots contribute to increased food production as the local people adapt to wetland conditions.

Vegetables were the main source of income at Dufuya, Madigane and Tugwi. This result is similar to that of Nabahungu and Visser (2011) which shows that 71.4% of farmers grow vegetables for income generation in reclaimed wetlands of Rwanda. A significant positive relationship ($r = 0.20$; $p = 0.03$) was shown between number of meals and wetland income, as the number of meals increased with the amount of income obtained. Although poorly developed marketing system marked by volatile prices affected net cash income, each household obtained on average US\$527.13 per year from wetlands. This translates to an average of US\$43.92 per month per average household of 5.9 persons (or US\$7.44 per person). Zimbabwe's poverty datum line (PDL) is pegged at US\$100.58 per individual per month (and US\$502.90 for a family of five) (Ministry of Finance and Economic Development 2014). Although wetland income is low by national standard as it contributed 8.7% of the current PDL, the revenue is very important to the needs of local people given their limited livelihood options. This finding also confirms those of Adekola et al (2008) in South Africa, Rebelo et al (2010) in Tanzania and Turyahabwe et al (2013a) in Uganda.

High incidences of food insecurity were recorded at Guruguru and Zungwi where environmental degradation, attributed to use of BR/BF technology was reported. However, where tried and tested strategies, in terms of environmental conservation and institutional arrangements were in place (e.g. Dufuya and Tugwi), wetland protection was improved,

unlike in Guruguru and Zungwi, where the BR/BF technology was introduced as an experiment (Mberekó 2008). All respondents at Guruguru and Zungwi indicated that the technology was not a low-cost option; hence it was difficult for cash-strapped communities to effectively manage it. This result confirms that of Liniger et al. (2011) that successful projects should be sensitive to local needs and conditions.

The results of the study further revealed that conservation of a wetland can be a major determinant to attainment of household food security. Although some negative environmental impacts of cultivation (such as reduction in soil moisture, soil fertility, water quality) were qualitatively revealed through key informant interviews and household perceptions, generally wetland protection was largely effective in most of the wetlands except at Guruguru and Zungwi, where wetland loss was attributed to the mismanagement of the externally-driven introduced BR/BF cultivation system due to lack of social cohesion and financial resources. Thus Dixon (2005) emphasizes the importance of experimenting and adapting local technologies to existing environment. Moreover, well-organized committees like at Tugwi contributed to effective adoption of conservation strategies. These results are similar to that of Sakané et al. (2013) who observed variations in negative effects of cultivation practices on wetland hydrology and soils to be inextricably linked to management systems.

A number of soil and water conservation strategies were adopted by communities although variations were noted between sites. Preventive and/or mitigating practices introduced at Chebvuterambatemwa, Dufuya, Madigane and Tugwi include mulching, composting, green and animal manure, minimum burning of crop residue, basin tillage, crop rotation, infiltration pits and fencing. Since soil and water conservation are key pillars of sustainability, most farmers across the sites indicated that these techniques improved soil quality and moisture retention. Most importantly, effective implementation of these strategies is enhanced by local policing. This shows that if local communities are empowered, they can be custodians of wetland resources by establishing appropriate governance structures to monitor use of the resource. Nabahungu and Visser (2011) revealed that local farmers have sufficient knowledge on the causes of wetland degradation and possible solutions to overcome constraints.

The results of this study further demonstrated that to achieve sustainable land management, focus should not be on protecting the quality of the environment only, but also to promote

social and economic stability. The success of wetland-based food security projects relied on the adoption of sustainable, human-centred local strategies that improved livelihood benefits. For instance, at Tugwi, the reduction of post-harvest losses, peer to peer training on production and conservation, family involvement in implementation of organic farming principles, development of indigenous crop varieties seed banks and use of botanical pesticides contributed immensely to benefits obtained by the local community. Unlike at Rugeramigozi wetland in Rwanda, where farmers have insignificant influence on the policies of their co-operatives (Nabahungu and Visser 2011), at Dufuya, Chebvuterambatemwa, Madigane and Tugwi, there was greater community involvement in decision making. Moreover, gender mainstreaming as shown by equal representation in committees at Tugwi was key to sustainable wetland use. Despite poor knowledge and enforcement of wetland law, local people instituted sound wetland use and management practices in Chebvuterambatemwa, Dufuya, Tugwi and Madigane. Instead, results of this study revealed that synergies were developed between local people and regulatory authorities, a position which improved sustainable use of wetlands.

Organic certification as shown at Tugwi has potential of increasing sustainability of wetland cultivation due to a number of social, economic and ecological opportunities presented. Such measures as the prohibition of chemical fertilizers, pesticides and herbicides in favour of local inputs from plants and animals, composting and green manure are likely to have positive implications on the ecological condition of the wetland. Moreover, a shift to local chemicals and development of seed banks will assist local communities to save their limited financial resources given that incidences of poverty were observed to be high in Chapter 1. The involvement family members in organic farming assist in generational transfer of knowledge; hence continuation of the adopted sustainable cultivation practices. Therefore, organic certification should be encouraged as a strategy to enhance sustainable wetland cultivation though the ecological implications local chemicals may need further scientific validated.

The results of this chapter show that the environmental sustainability of wetland-based food security projects relies more on the effective participation of local communities and adoption of environmentally friendly technologies and approaches. The adopted use strategies should

be sensitive to local conditions and needs, if they are to be effective, as largely shown at Dufuya and Tugwi. Where food security benefits are realised, local people were eager to participate in natural resources management as demonstrated by establishment of supporting local regulation institutions.

6.5 References

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CHAPTER SEVEN

IMPACTS OF HUMAN ACTIVITIES AND MANAGEMENT STRATEGIES ON WETLAND PROCESSES: A SYNTHESIS

As has already been indicated, wetlands are one of the most productive ecosystems in the world (Mitsch and Gosselink, 1993) as they provide a wide range of ecosystem services which benefit human beings and the environment (Island Press, 2007; Russi *et al.*, 2013). However, several studies pointed out that the loss of wetlands is taking place at an unprecedented rate (Finlayson and Spiers, 1999; von der Heyden, 2007), mainly due to diverse human activities and the associated management strategies (Maconachie *et al.*, 2008; Dixon *et al.*, 2013), also in Zimbabwe. In response to wetland degradation and loss, strategies for use and management have been developed and implemented at various scales (IWMI, 2014). Nonetheless, the foregoing work has shown that spatio-temporal variations were recorded in the degree of success of the strategies, and this has been observed to be influenced by differences in existing land use and institutional structures in relation to wetland's hydrogeomorphic type.

The research has also shown that wetland use and management, if not carefully monitored, can pose challenges in planning, policy making, management and conservation. Furthermore, there is an inconclusive debate in literature on how and why wetlands continue to be utilized in an unsustainable manner in developing countries, including Zimbabwe (Rebello *et al.*, 2010; Verhoeven and Setter, 2010; Marambanyika *et al.*, 2012; IWMI, 2014). An integrated management strategy, involving understanding of use patterns, effects of land use on biophysical conditions, the influence of institutions and policy on wetland ecological conditions through use, and evaluation of community strategies to sustain wetland-based food security is needed. It is important to note that, before Zimbabwe encouraged wise use of wetlands under the current legal dispensation dating back to 2003, wetland degradation was on the increase. Again, no information had been available to account for the current land use, institutional frameworks and the ecological state of wetlands in Zimbabwe. The research, through focusing on the stated set of objectives has remedied this. The findings of the research can be summarised focusing on the following key topics:

7.1 Wetland utilization patterns and associated benefits to surrounding communities

Several studies revealed the need for periodic evaluation of individual wetland types so as to understand their value and ecological conditions in relation to use to ensure planning of

sound wetland management. The changing land use patterns and the benefits derived from wetlands for surrounding communities were examined using remotely sensed data. The results of the study show that cultivation is the predominant land use activity and the cultivated area increased by 7.7% between 1985 and 2013 but at the expense of wetland size. Increased cultivation was accompanied by a reduction in vegetation cover. Changes in extent of cultivated area were caused by increasing rainfall variability, making dry land farming less productive and resulting in a decline in soil fertility in arable fields. The inclusion of people in wetland use using techniques such as BR/BF and canals led to bare land extending on the wetland fringes, a sign that wetlands are degrading. Bare area increased by 123.1% between 1996 and 2013 and it now occupies 24.9% of the total wetland area as compared to 8.6% in 1985.

Many households and most of the elderly people (41% of respondents) indicated that wetlands are losing their socio-cultural significance, and that the range of natural products harvested has declined due to modifications taking place in the wetlands as a result of expanding cultivation. This demonstrates that, although cultivation is important to the economy of local communities, it is a threat to existence of wetlands and the range of associated goods and services. Households' dependency on wetlands is high as confirmed by statistical significance through Wilcoxon Signed Rank test ($p < 0.05$), as they obtained more than 60% of their income from this resource.

7.2 Environmental sustainability of cultivation systems in wetlands

The understanding of the interaction between wetland processes and land use is essential to achieve sustainable land management (Euliss *et al.*, 2008; Mekiso *et al.*, 2013). This evaluation is critical since the degree of wetland sensitivity to human activities is largely unknown in most developing countries (Sakané *et al.*, 2011). Prior to this work, no research in Zimbabwe had given a holistic picture of the overall wetland condition as the work most often targeted specific facets of a wetland, such as the vegetation, the soils and the hydrology.

Use of WET-Health framework in this study, has demonstrated that cultivation methods impacted on wetlands hydrology in different ways. The present hydrological condition of Dufuya was rated as moderate, Guruguru as critical and Zungwi as small. The state of

hydrological conditions in the wetlands was mainly affected by specific cultivation methods within the wetlands rather than human activities taking place in the upstream catchments. Effective soil conservation measures and presence of vegetation in the upstream catchments did not alter the water input into the wetland. Concrete canals covering approximately 30% of the Dufuya wetland resulted in drying of the affected section whereas wet conditions were observed to be expanding in unaffected areas. Broad ridges and broad furrows (BR/BF) covering the entire of Guruguru and 21.6% of Zungwi affected the hydrological processes through drainage, encouraged water retention and resulted in flooding of adjacent non-wetland arable land. In Zungwi, the expected resuscitation of cultivation on BR/BF may further deteriorate the wetland's hydrology. A lack of rehabilitation of Guruguru wetland is likely to result in its hydrological condition remaining in its current critical state. By contrast, as further construction of canals has been banned in Dufuya, and regulations of wetland use are strictly enforced, no further change in hydrological state is expected.

The results of this work further showed that the likelihood of increasing sediment load due to soil erosion in the upper reaches has been effectively controlled by soil conservation measures such as contour ridges in cultivated areas and the presence of vegetation. Overall, there was very little geomorphological activity in Guruguru and Zungwi, whereas in the Dufuya wetland, the geomorphic processes were moderately modified by a gravel road passing through the wetland and a small gully found at the head. Headcut erosion threatens the existence of the wetland if not well controlled. The eroded sediment is entirely deposited in the wetland and there is very little evidence of depositional features as the rate of vegetation growth is able to colonize and stabilize the influx of sediment at present. There is a likelihood of gully erosion occurrence in both Guruguru and Zungwi in the event of dam bursting and/or overtopping, since small dams at the mouth were constructed without spillways. Cultivation also resulted in serious modification of vegetation structure and species composition in the three wetlands with invasion by weed species peculiar to non-wetland conditions. Alien species like *Lantana camara* and ruderal species such as *Eragrostis sp.*, *Perotis patens*, *Pogonarthria squarrosa* and *Triraphis schinzii* have also been identified.

7.3 Institutional arrangements governing wetland utilization and conservation

There is need to target key factors at play at each wetland if it is to be effectively managed. Several studies pointed to successful management of wetlands on being achieved if there is an understanding of relationship between wetland conditions and existing institutions. Despite Ramsar guidelines, information regarding the institutional governance of wetlands in Zimbabwe was seriously lacking prior to the present study.

The results showed that the whole wetland management process is driven by several institutions and by local people. Local institutions involving traditional leaders and wetland committees were found at each wetland site alongside external institutions such as government departments, local authorities and NGOs. The number of institutions participating at each of the different wetlands varies, and some institutions were more involved in wetland use than conservation and vice versa. It is likely that different situations at different sites call on different levels of involvement and harmony in the operation of those institutions. The way different institutions participated was influenced by different institutional mandates and priorities torn between socio-economic and environmental considerations. Agritex, traditional leaders, wetland committees and to a lesser extent local councillors and youth officers determined local people's involvement in wetland use. NGOs balanced use and conservation by providing fencing material and inputs for wetland farming and establishment of wetland-based food security related projects. Councillors encouraged extension of cultivation, in most cases against conservation advice from traditional leaders, wetland committees and the EMA. Government agencies participated in wetland conservation through education, awareness and monitoring of legal adherence. What is clearly evident from the results is that some institutions are not consistent in the execution of their mandates as they sometimes encourage or discourage cultivation methods that damage wetland ecosystems.

The institutions responsible for promoting conservation were less visible and effective compared to those promoting use. There was poor coordination of institutional roles sometimes resulting in degradation. Traditional leaders and wetland committees were more visible in wetland management than government agencies. Relations were not always cordial, especially between government departments, NGOs and some government departments, due to overlapping and conflicting roles. Where different institutions properly work together,

wetlands were better conserved as in the case of Tugwi. Therefore, the absence of a clearly defined institutional framework act as an obstacle to effective wetland governance as institutional duties are not clearly defined; hence overlaps and conflicts which can be avoided. In light of absence of a clear institutional structure, the legal and policy framework governing wetland management was investigated.

7.4 The missing link between awareness and the implementation of wetland policies

This work evaluated substantial evidence of stakeholder's perceptions of the effectiveness of legislation and policies governing wetland protection. This information had been lacking in the current wetland management discourse of Zimbabwe, especially after transformation of the legal framework, with the introduction of the EMA Act in 2003. The results showed that the majority of the people (61.8%) were not aware of the existence and rationale of wetland laws. This may explain why all wetlands were used without permits as required by the current law. As a result, effective wetland management was periodically disrupted by illegal activities such as draining, drilling and introduction of exotic trees.

Moreover, the results have shown that wetland policy of Zimbabwe is not able to control and direct management at the levels where it is needed. However, local policies guiding wetland use and conservation were present at each wetland site. Where local rules and regulations were effectively applied through traditional leaders and wetland committees, wise use of wetlands was largely achieved, as in the case of Chebvuterambatemwa, Dufuya and Tugwi. Poor knowledge of national wetland law was seen to be due to poor education and awareness creation by the responsible institution, the EMA, and poor attendance at ad hoc meetings mainly convened in response to problems. On the other hand, poor implementation of national wetland law was mainly caused by socio-economic and institutional factors. These include high incidence of poverty, political interference on institutions' functions, inadequate financial and human resources for government agencies, inconsistencies in levels of prosecution, local people' poor knowledge of the law, corruption and nepotism, inconsistencies in dissemination of legal provisions by different institutions, resistance to change by individuals and failure to value wetland as a resource. Therefore, this prompted the need to investigate how local communities were sustaining wetland-based food security

activities in light of discord in the institutional framework and poor implementation of national wetland law.

7.5 Coping strategies to minimize wetland degradation towards household food security

Literature has shown that the use of wetland to promote household food security is widespread in developing countries where community dependence on natural resources is high with several studies viewing wetland agriculture as the most significant threat to wetland ecology. One of the major constraints to sustainable use of wetlands for food security was found to be the lack of information on natural resources that can be used by planners and managers to achieve sustainable utilization

The results have demonstrated that 60% of households utilizing wetlands were food secure over the past decade, although significant variations were shown between wetlands ($p < 0.05$). The average household number of meals per day was 2.59. Almost all food insecure households were found adjacent to the degraded Guruguru and Zungwi wetlands. Households obtained an estimated half of their food from wetland cultivation. On average 67% of vegetables and 3.4% of maize was sold, thereby contributing 64.7% of the average household total cash income. Wetland income was observed to be high in households which have been using wetlands for long and those with larger plots (> 0.03 ha). Spearman correlation coefficient results showed that a significant positive relationship ($r^2 = 0.04$; $p < 0.05$) exists between household wetland income and number of meals.

Despite poor knowledge and enforcement of wetland law, local people at Chebvuterambatemwa, Dufuya, Madigane and Tugwi instituted soil and water conservation measures to protect wetland ecosystems. Effective enforcement of these provisions was monitored through local policing, resulting in expulsion of people who violated these principles. Reduction in post-harvest losses, peer to peer training, family involvement in implementation of organic principles and promotion of traditional crop varieties improved net community gains and promoted sustainable use of wetlands.

7.6 Conclusion

The main focus of this research was to understand the impacts of human activities and management strategies on wetland processes in the communal areas of the southern part of Zimbabwe.

Using land cover and land use (LCLU) change analysis, it was shown that there was no change in major land uses as cultivation remains the predominant activity. The cultivated area and bare land has been increasing in size, suggesting that wetland conditions are being modified. Increasing wetland cultivation is driven by declining dryland farming produce, market availability for horticultural produce and implementation of donor-driven food security projects. Although community dependence on wetlands is high, though spatially heterogeneous, it was shown that the reduction in vegetation cover has resulted in loss of some natural products and services provided by the wetlands. This suggests that cultivation reduced the range of natural goods and services directly obtained from pristine wetland. Therefore, information on community dependence on wetlands should be accounted for and factored into local conservation planning, since it influences both use and conservation of wetlands.

It has further been shown that on-site wetland cultivation activities, especially BR/BF and concrete canals, rather than land uses in the upstream catchment area, were responsible for the modification of the present wetland hydrological state and degradation of vegetation structure and composition. Catchment areas are effectively protected by existing soil and vegetation conservation measures, implying that more conservation attention should be focused within wetlands. The development of concrete canals and BR/BF cultivation system in wetlands did not carefully consider how water distribution and retention (surface and sub-surface flow) can be altered through drains interception, increased evaporation surface and channeling away of water to adjacent non-wetland area. There was very little evidence to suggest that erosion and deposition was actively taking place within the wetlands.

Findings further showed that not all cultivation methods contribute to wetland drying as conservation farming practices involving minimum soil disturbance and vegetation strips left at plot boundaries were associated with the expansion of wetland conditions to adjacent non-wetland area in Dufuya. This demonstrates that attention should be given to assessment of the

appropriateness of cultivation methods rather than prohibiting wetland cultivation based solely on evidence of ‘failed’ methods that contribute to drainage and drying. The selection of sustainable land use options should be based on a clear understanding of particular vulnerabilities of a wetland. Hence there is need to continue searching for sustainable wetland cultivation methods, in particular, those that can be adapted to local conditions and needs.

Several institutions are influencing wetland use and management by local people. This includes government departments, traditional leaders, wetland committees and NGOs. Although the level of participation and cordiality of existing relations between institutions vary from each wetland site, traditional leaders and wetland committees were involved in the entire wetland management process in different areas. The level of wetland conservation mainly depended on the level of participation of these two local institutions. The degree of participation by other institutions varies, with institutions responsible for promoting wetland conservation less visible than those promoting use. The roles and mandates of different institutions should be clearly defined to minimize discord and conflicts between institutions which sometimes result in wetland degradation.

It is argued that a multi-sectoral approach to wetland governance is important and unavoidable; hence a proposal for the establishment of a sound institutional structure involving local people and interested institutions. In the proposed institutional structure, roles and synergies between different institutions should be clearly defined if sustainable wetland utilization is to be achieved. Local institutions led by traditional leaders and wetland committees should be placed at the centre of the proposed institutional framework given their proximity to users and the resource. The incorporation of local institutions at the centre of wetland governance system may provide a low-cost option to wetland management in resource constrained countries like Zimbabwe given their proximity to both wetlands and users and the fact that the performance of government institutions was incapacitated by limited financial and human resources. Nonetheless, local authorities and government agencies should play an advisory and supervisory role to ensure that the principles of sustainable land management as envisaged under the standardized WOCAT methodologies are complied with at local level.

Little awareness and poor implementation of wetland law sometimes resulted in adoption of practices that degrade the wetlands, such as draining and drilling. An array of socio-economic and institutional challenges explained the current knowledge and level of implementation of the current law. However, wetlands were used and conserved through local policies, some of which vary between wetlands, in terms of scope and thrust. The local policies assisted in conservation of wetlands with different levels of success. Sadly, the country has no national policy to guide wetland governance, a situation which undermines the review of wetland protection strategies and intensifies discord in wetland management at sub-national level. A national wetland policy, developed through a participatory process, should assist to promote adoption of relevant local rules and regulations and encourage their sharing and possibly adaptation in different local contexts. Moreover, the national policy should encourage monitoring and documentation of local rules and regulations and ensure continuous compliance to all local policies regarding sustainable wetland utilization.

There is a need to mobilise revenue and resources to empower regulatory institutions to effectively educate and supervise communities' adherence to the pertinent legal framework. However, given the prevailing macroeconomic challenges in Zimbabwe which limit availing of adequate enforcement funds, it would be also wise to recruit voluntary wetland monitors at local level who can be periodically paid through part of revenue generated from nabbing of users engaging in activities undermining wise use of wetlands. Nonetheless, results of the study further reveal that effective enforcement can be achieved by first synchronising by-laws and national law penalties in order to minimize the current prosecution discord.

Lastly, the results of the study showed that most households using wetlands were food secure and they had developed effective strategies to protect wetlands. Hence, the sustainability of wetland-based food security projects rely more on the effective participation of local communities and the adoption of local environmentally friendly technologies and approaches. Community participation assists in prevention and/or mitigation of negative environmental impacts, especially where local resources were used in both food production and wetland conservation, unlike in Guruguru and Zungwi where high cost technology was introduced. The results of the entire thesis demonstrated the need for a holistic; people-centred approach to wetland management which also considers the environment.

7.7 Recommendations for the future

The research presented here has explained the importance of understanding the effects of both land use and related management strategies in the protection of wetland ecosystems. This information provides insights to wetland researchers and managers, environmentalists and researchers, to shift towards an integrated approach to wetland management, a situation which can facilitate effective and sustainable utilization of wetlands in Zimbabwe, a situation currently lacking. Therefore, the findings of this study provide baseline information that can be considered in the formulation of wetland resources management frameworks based on an understanding of socio-economic and ecological processes. This has enabled the following recommendations for future research to be made:

- Research should concentrate on long term monitoring of land-use and management strategies on wetlands of different hydrogeomorphic type in order to build datasets and frameworks to assist in wetland management in Zimbabwe.
- Long term monitoring of geomorphic processes in wetlands is required since rapid inspection of ecological conditions can provide little understanding of the problem. For instance sediment load from gully development in Dufuya needs to be measured continuously.
- The continued dominance of cultivation in wetlands and its importance to community food security also calls for further research on suitable methods to promote sustainable cultivation in wetlands of different hydrogeomorphic types.
- Research should be focused on wetland rehabilitation and restoration, especially those affected by BR/BF and other land uses.
- More research should be conducted on wetlands in relation to politics, to understand why politics remains a major challenge in wetland governance and protection.
- The contribution of WET-Health method can be improved if it is applied together with spatial mapping techniques. The WET-Health method alone gives us a snapshot of wetland conditions but the use of remote sensing data provides a spatial component and even historical data which is rather subjective or sometimes unavailable through questionnaires and interviews.
- Certification to organic farming in wetlands has the potential to improve sustainable cultivation of wetland. This method was observed to rely on low-cost local inputs such chemicals, fertilizers and indigenous seeds adapted to local conditions and has a social

system which allows generational transfer of knowledge; situations which has positive implications on the social, economic and ecological dimensions of sustainability. However, there is need for further research on the effects of local pesticides and herbicides used by local communities on the environment given the potential of organic certification to assist in sustainable wetland cultivation.

7.8 References

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Appendices

Appendix 6.1: Summary of internal organic standards and sanctions

Standard	Sanction
1. Synthetic chemical fertilisers are prohibited	1. The penalty for using synthetic chemical fertilisers is the termination of membership from the project.
2. Only organic fertilisers may be used and can utilise animal wastes, plant residues, green crops and mineral inputs.	2. The penalty for using inorganic fertilisers is the termination of membership from the project.
3. Synthetic chemical pesticides and herbicides are prohibited.	3. The penalty for using chemical pesticides and herbicides is the termination of membership from the project.
4. The use of botanical pesticides and approved raw minerals is allowed.	4. The penalty for using inorganic fertilisers is the termination of membership from the project.
5. Farming equipment used for conventional farming must be cleaned before use on organic farm.	5. If inorganic farming equipment is used on organic land without cleaning it produce will be condemned.
6. Bags and containers used to harvest and transport organic products must be clean on clearly labelled organic only and should not have been used to store non-organic crops.	6. If bags and containers are not clean and clearly labelled 'organic only' the above sanctions (5) will be applied.
7. All GMO'S are prohibited.	7. If the planting and harvesting of GMO products is to be discovered the member will be immediately terminated from the project and the issue will be reported to the relevant authorities.
8. Farmers must have measures in place to stop erosion.	8. Different stakeholders are to be involved in capacity building and given deadlines to ensure that conversation practises are followed.
9. Burning of green material and crop residue should be minimised.	9. If burning of crop residues is not minimised the farmer is liable to pay a fine equivalent to the value of a single chicken.
10. Livestock must be treated in a humane way.	10. If livestock is treated in an inhumane way the transgressor will be reported to VET.
11. The conversion period to full organic production is 36months from the last documented use of a prohibited input. Other farms may be certified	11. Fully organic farms will be certified organic in 24 months anything below that will be deemed in the transitional phase.

transitional.	
12. Each farmer maintains regular attendance in the PGS Organic meetings of their local group.	12. If farmers do not regularly attend PGS Organic meeting of their local group they are to be fined \$5 if absence continues they may eventually be dismissed from the project.
13. Each farmer must take an Organic pledge.	13. No farmer will be accepted as a member of a project if she/he does not take an organic pledge.
14. Each farmer, must have successfully completed a peer –appraisal of at least one other farm, and have had a successful peer review own farm.	14. If a farmer is not inspected and does not participate in peer-peer inspection they are not to be certified and will be terminated from the project.
15. There should be adequate sanitary facilities for use when working in organic fields.	15. No operations are to be conducted before sanitary facilities are built in or around organic fields.
16. Smoking and sniffing is not allowed when working in Organic fields and during processing of organic products.	16. Smokers and sniffers are to be fined \$10 if caught smoking /sniffing in organic fields or processing areas.
17. Water harvesting structures must be put in place around gardens and fields.	17. If water harvesting structures are not built around gardens and fields they are to be taken to the relevant stakeholders such as Agritex for capacity building.
18. Organic fields and gardens must be protected from conventional gardens.	18. Buffer zones are to be created between conventional and organic farms if not produce will be condemned on the market.
19. Every farmer and his/her family must practise organic standards.	19. If a farmer and his/her family members do not practice organic farming standards no certification will be awarded.
20. Every farmer must report malpractices by fellow organic farmers.	20. If farmers do not report malpractices by their fellow organic farmers they are to be removed from the project.
21. Every Organic farmer must clean the surrounding of his/her garden.	21. If an organic farmer does not keep his/her garden cleaned they are to be fined \$5 whilst the garden members will pay \$1 each.
22. Agritex officers must be a part of the inspection team.	22. If Agritex officials are not part of the inspection process the inspection results will be nullified.
23. Dogs are not to be allowed in Organic fields.	23. If dogs are discovered in the organic fields the farmer responsible will pay a fine of \$5 and his/her crops will be condemned.
24. Every Organic farmer must meet all	24. If a farmer does not meet agreed upon

deadlines agreed upon by the group e.g. land preparation time, planting and harvesting time.	deadlines they are to pay a fine of \$10 and if it continues they may eventually expel him/her from the project.
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