Effects of interactions between governance, intergenerational and gender dimensions on smallholder irrigation scheme in KwaZulu-Natal, South Africa

By

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DEDICATION

To my late Dad, I hope you are proud!

DECLARATION 1 – PLAGIARISM

I, Senamile Fortunate Dlangalala, declare that;

1. The work contained in this thesis is my original research investigations and findings.
2. Information other than my own was re-written and acknowledge as being sourced from other researchers. Where information was directly extracted from the source, quotation marks were used and referenced. A list of references was appended.
3. The work contained in this thesis has not been previously submitted for any degree or examination at any other university. Acknowledged and a reference list has been appended.

Signed _____ Date_____

As the candidate's supervisor, I, Maxwell Mudhara, agree to the submission of this thesis;

Signed _____ Date_____

DECLARATION 2 – PUBLICATIONS

The following publications (presented and under review) form part of the research presented in this thesis.

Manuscript 1 - Chapter 4 of this thesis

Dlangalala, S.F. & Mudhara, M. Determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in smallholder irrigation schemes in KwaZulu-Natal Province, South Africa. (Under review: *Water SA*)

Conference Paper

Dlangalala, S.F. & Mudhara, M. 2018. Determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in smallholder irrigation schemes in KwaZulu-Natal Province, South Africa. Paper presented at the 19th WaterNet/ WARFSA/ GWP-SA Symposium, 31 October – 02 November 2018, Avani Victoria Falls Resort, Livingstone, Zambia.

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ABSTRACT

Smallholder irrigation schemes (SISs) face several challenges hindering them from performing at satisfactory levels. In South Africa, the government made considerable financial investments in developing SISs and revitalising them to improve their performance. However, poor performance persisted, indicating that the key root of poor performance could lie elsewhere, e.g., weak institutional arrangements, an aspect which is often overlooked, and in an inequitable distribution of land and other productive resources across intergenerational and gender dimensions. Researchers have argued that the absence of effective management regimes was underpinning the poor performance of SISs.

This study sought to assess the effects of the interaction between governance, on one hand, and intergenerational and gender dimensions, on the other, on the performance of SIS in KwaZulu-Natal, South Africa. The specific objectives were to describe the institutional arrangements for water management in SISs, to identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs, and to investigate the effects of governance on cropland allocation across gender and intergenerational dimensions in SISs. The study was conducted in Mooi River, Tugela Ferry Irrigation Schemes located in Msinga Local Municipality and Ndumo Irrigation Scheme located in Jozini Local Municipality. Primary data were collected through focus group discussions, key informant interviews and a structured household questionnaire administered by Zulu-speaking enumerators. Stratified and systematic random sampling techniques were employed to select survey respondents.

Empirical models used were the Descriptive Statistical technique, Principal Component Analysis, Ordinary Least Squares technique and Fractional Regression Generalized Linear model. The results indicated that the studied irrigation schemes had functional institutional arrangements, and all schemes had scheme committees, i.e., the leaders responsible for ensuring that all the scheme rules and policies are obeyed. Furthermore, the study revealed that formal water institutions were unknown and non-existence at the local level which led to a high reliance on informal institutional arrangements for water resource management. The statistically significant determinants of farmer awareness of water governance dimensions were along the gender, level of education, water management training, scheme location, membership in water users association, stakeholder participation, farmer's involvement in scheme decision-making processes, and source of information. Age of an irrigator, size of a plot, type of land

ownership, access to credit, revenue (farm income), and irrigation water sufficiency were found to have a significant influence on cropland allocation decisions. Through the application of Fractional Logit Generalised Linear Model, the study concludes that gender of an irrigator, farmer perceptions with scheme water governance and irrigation water schedule do not influence farmer decisions on cropland allocation in Mooi River, Tugela Ferry and Ndumo irrigation schemes.

There is a need to raise irrigators' awareness about formal water institutions, their intentions and the importance of knowing them. In addition, irrigators need to be capacitated on best management practices and in making informed production decisions. Therefore, improvements in communication between irrigators and external stakeholders are critical. Moreover, government and policymakers must incorporate customary laws when formulating national laws to increase compliance by smallholder irrigators with formal water institutions.

LIST OF ACRONYMS

CMA	Catchment Management Agency
CPR	Common Property Resource
DAFF	Department of Agriculture, Forestry and Fisheries
DARD	Department of Agriculture and Rural Development
DAS	Directorate of Agricultural Statistics
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
FAO	Food and Agriculture Organization of United Nations
FLGLM	Fractional Logit Generalized Linear Model
GDP	Gross Domestic Product
GWA	Gender and Water Alliance
GWP	Global Water Partnership
HDI	Historically Disadvantaged Individuals
IMT	Irrigation Management Transfer
IWRM	Integrated Water Resources Management
KMO	Keiser-Meyer-Olkin
MC	Management Committee
MRIS	Mooi River Irrigation Scheme
NDP	National Development Plan
NGP	New Growth Path
NIS	Ndumo Irrigation Scheme

NWA	National Water Act (No. 36 of 1998)
NWRS	National Water Resources Strategy
OLS	Ordinary Least Squares
PC	Principal Component
PCA	Principal Components Analysis
PTO	Permission to Occupy
RESIS	Revitalisation of Smallholder Irrigation Schemes
RSA	Republic of South Africa
SA	South Africa
SIS	Smallholder Irrigation Scheme
Stats SA	Statistics South Africa
TFIS	Tugela Ferry Irrigation Scheme
VIF	Variance Inflations Factor
WAR	Water Allocation Reform
WUA	Water Users Association

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CHAPTER ONE: INTRODUCTION

1.1 Background

South African agriculture can be understood as being dualistic or dichotomous consisting of commercial farmers and smallholder (Department of Agriculture, Forestry and Fisheries (DAFF), 2015; Moswetsi *et al*., 2017), jointly occupying about 1 354 127 million hectare (ha) of total irrigated area where 40 624 ha (3%) are smallholder irrigation schemes (SISs) (Fanadzo, 2012; Stevens & Van Koppen, 2015). In South Africa (SA), agriculture is a primary source of livelihood for about 200 000 – 230 000 rural black people (Magingxa *et al.,* 2009 and acts as a source of income and employment (Naamwintome & Bagson, 2013). The agricultural sector employs about 35% of the total population globally and about 86.8% in Africa, SA included (Naamwintome & Bagson, 2013). Between the period 1948 to 1962, the agricultural sector played a substantial role in providing employment for South African population which grew at an average of 0.88% annually. However, this rate declined by 1.52% between the period of 1963 to 2010 due to government policies impeding export opportunities and encourage the adoption of labour-saving technologies (Greyling, 2012). Despite all this, agriculture remains an important sector in terms of employment in SA (Xingwana, 2007). The Directorate of Agricultural Statistics (DAS) (2015) indicated that the contribution of the agricultural sector to the Gross Domestic Product (GDP) in SA is relatively small and continuously dropping. In 1969, the sector made about 7.7% contribution in the GDP, 5.3% in 1988 while it contributed about 2.5% in 2015 (Grain SA, 2015).

SA experiences shortages in water supply with increasing water demand for irrigation and water basic needs. On average, over 60% of the country receives below 500 mm of rainfall per annum and thus considered as the 30th driest country in the world (Fanadzo & Ncube, 2018). Projections reveal that most parts of the world currently experience water scarcity will become drier and more prone to droughts (Johansson, 2016). The agricultural sector is expected to meet the increasing food demand emanating from the expanding world population, that is estimated to reach 8.5 billion by the year 2030 with unreliable rainfall patterns and increasing water scarcity (Fanadzo & Ncube, 2018). In this situation, irrigation becomes an alternative. It stabilizes food production as it safeguards against erratic rainfall patterns (Van Averbeke *et al.,* 2011; Cobourn *et al.,* 2017). According to Svendsen *et al.* (2009) and Garcia-Bolanos *et al.* (2011), most African countries have realised the potential of irrigation in enhancing agricultural

productivity, creating employment, promoting economic growth and thus, contributing to poverty reduction. About 9.5% of the total cultivated area in SA is under irrigation (Svendsen *et al*., 2009) and consumes approximately 62% of available water in the country (Fanadzo & Ncube, 2018). Therefore, efficient use of irrigation water is critical as irrigation is the largest consumer of water and where most water losses occur, approximately 30 – 40% (Fanadzo & Ncube, 2018).

Following the recognition of the irrigation potential, the government established SISs to improve rural livelihoods through sustainable food production for food security and poverty alleviation (Fanadzo & Ncube, 2018). In SA, SISs are viewed as one of the key strategies for increasing agricultural productivity in communal areas and for achieving the key objectives of the National Development Plan (NDP) and the New Growth Path (NGP) (Cousins, 2013; Sinyolo *et al*., 2014; Mvelase, 2016). The NDP intends to eliminate poverty and reduce inequality by the year 2030 (The Government of South Africa, 2018). It proposes that the NDP-Vision for 2030 can be realised through the expansion of smallholder farming. The NGP aims to enhance growth, create employment and equity (The Government of South Africa, 2018). It proposes to create five million jobs over the next ten decades. It further clarifies that of the five million jobs, one million can be created through labour-intensive forms of small-scale farming in communal areas and on redistributed land, with many engaged in irrigated farming (Cousins, 2013). However, the development objectives of the SISs remain largely unfulfilled due to several challenges hindering them from performing at satisfactory levels (Fanadzo & Ncube, 2018).

1.2 Problem Statement

There has been a widespread concern about the poor performance of SIS in SA as most researchers who have assessed the performance of SISs in SA indicated that many of them performed below the expected levels (Machethe *et al*., 2004; Ntsonto, 2005; Fanadzo *et al.*, 2010; Mnkeni *et al.*, 2010; Dlamini, 2013; Fanadzo & Ncube, 2018). The low performance among SISs and the subsistence basis of their operation prevent irrigators from increasing their productivity and cash income (Ntsonto, 2005). So far, smallholder irrigation in SA has made relatively low economic contributions (Ibid.). Typically, this poor performance of SISs has been associated with several factors such as unfair land distribution, poor maintenance of infrastructure and equipment, high energy costs where pumping was involved, lack of institutional support in terms of credit, low returns to production, lack of extension and farmer

training, lack of technical knowledge, high dependency on government, conflicts, poor operational and management processes, weak local organization, etc (Biswas & Tortajada, 2010; Fanadzo *et al.*, 2010; Van Averbeke *et al*., 2011; Muchara *et al.*, 2014; Fanadzo & Ncube, 2018).

Policy makers and the government believe that increasing the number of SISs and revitalising existing and abandoned schemes, can increase food output, reduce poverty within the rural communities and improve the performance of SISs (Van Averbeke *et al.,* 2011; Fanadzo & Ncube, 2018). As a result, the SA government invested approximately two billion Rands in establishing, revitalising and rehabilitating SISs (Ntsonto, 2005; Denison & Manona, 2007; Van Averbeke *et al*., 2011; Fanadzo, 2012, Mvelase, 2016). Despite considerable government investments, the performance of SISs is claimed to be below potentials, indicating that the key root of poor performance could be weak institutional arrangements as this aspect in irrigation schemes is often overlooked. Jonckheere & Liversage (2017) argued that technology improvements alone are not enough to ensure productivity improvements and sustainability of irrigation schemes, rather appropriate institutions and property rights accompanying technical improvements are necessary for better performance and sustainability of SISs. Bromely (1992) cited by Wang (2011) argued that apart from increasing water scarcity, the absence of effective management regimes was the real cause of poor SISs performance. Fanadzo (2012) attributed the underperformance of SISs to both weak institutional and organizational arrangements and poor technical skills. According to Denison & Manona (2007), budget allocations for training, management and institutional development constitute a considerable share of the total intervention budget, approximately between 40–50%. Mnkeni *et al*. (2010) inferred that poor institutional arrangements and management in SISs make them dysfunctional. Hence, there is a great need for balancing the soft and hard component of an irrigation system to ensure sustainability (Fanadzo, 2010). This study dwells on the soft component.

Inequitable distribution of land and other productive resources across intergenerational and gender dimensions have also been noted in most African countries, which could also lead to the underperformance of SISs. Customary laws in most African countries restrict land ownership and inheritance by women (Mabundza *et al*., 2014). Also, the African norms of land inheritance often favour males, as it is only the sons who have better chances of inheriting land when the parents die (Dushimimana, 2007; Kosec *et al*., 2017). Women cannot access land on their own and can only access it via male kin (Mabundza *et al*., 2014). Even when a woman is the main farmer in the household, it is seldom that the land cultivated is registered under the

women's names (Mnkeni *et al*., 2010). This makes it difficult for women to acquire land and engage in farming.

Although youth do not seem to be interested in agricultural activities, lack of access to agricultural land is one of the major factors influencing their migration to urban areas for high-return non-agricultural activities (Kosec *et al.,* 2017). Generally, youth often acquire land through inheritance, given as a gift, borrowing from neighbours or informal rental markets, and do not hold land rights to where they cultivate. The absence of land markets in rural Africa also contributes to the difficulty in land accessibility by young people and landless households (Kosec *et al*., 2017).

The interaction between intergenerational and gender dimensions with water governance in communal irrigation schemes seem to be very weak. Water governance at communal level is gender-blind (Cleaver & Hamada, 2010). Women are often not recognized as independent farmers or irrigators; thus, they remain largely excluded from participating in decision-making processes in water resource management and governance such that their access to and control over water resources are limited (Cleaver & Hamada, 2010; Njie, 2013). This unequal treatment and opportunities across gender could largely be attributed to the lack of land rights by women (Mjoli *et al*., 2009). The rights and entitlements of resources may shape the ways in which women participate in mechanisms of water access such as in community water committees and how their voices are heard at the local level (Cleaver & Hamada, 2010).

1.3 Objectives of the Study

The main objective of the study is to assess the effects of the interaction between governance, on one hand, and intergenerational and gender dimensions, on the other, on the performance of SIS in KwaZulu-Natal, South Africa. The specific objectives were:

- To describe the institutional arrangements for water management in SISs,
- To identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs, and
- To investigate the effects of governance on cropland allocation in SISs.

1.4 Research Hypotheses

The study will be guided by the following hypothesis:

H1: The study irrigation schemes have no institutional and organisational arrangements for water management;

H2: Awareness of governance between youth relative to elderly and women relative to men is asymmetric;

H3: Age and gender of an irrigator does not determine farmer awareness of water governance dimensions; and

H4: Water governance has no effect on cropland allocation.

1.5 The Significance and Explication of Contribution of the Study

Despite the worldwide water scarcity due to high demand of water resources from various sectors relative to its supply, irrigation remains central to agricultural production (Johansson, 2016; Fanadzo & Ncube, 2018). The evidence indicates that smallholder irrigation farming has a long history although it has not yet succeeded in achieving the objectives for its establishment (poverty alleviation and food security) (Sinyolo *et al*., 2014). In communal areas, irrigated farming has been practised traditionally. Farmers used rivers as source of water for irrigating crops for subsistence (Ntsonto, 2005). Although traditional councils allocated plots on irrigation schemes (Cousin, 2012), yet it is unfortunate that farmers within traditional systems do not get equal representation and opportunities in terms of gender and age, especially when it comes to resource accessibility. For example, women can only access land through male relatives while youth usually acquire land through inheritance (Kosec *et al*., 2017). In some countries like Ethiopia, women and youth are not allowed to participate in discussions of land-related matters and decision-making forums, while their level of literacy and access to information are relatively low (Sida, 2003). Such scenarios are likely to result in divergence in the awareness of and the effects of governance dimensions across gender and intergenerational dimensions.

This study argues that the persistent unsatisfactory performance by SISs is institutionally related. It is therefore important to examine the effects of the interactions between governance, intergenerational and gender dimensions on SISs as this will give an insight as to how water governance dimensions affect their operation and viability. The study findings will be to the benefit of society since water resources play a vital role in irrigated agriculture and in the livelihoods of rural households. Furthermore, understanding the effects of the interactions

between governance, intergenerational and gender dimensions on SISs could also help the government in policy interventions aimed at developing SISs.

1.6 Outline of the Thesis

This thesis is structured in six chapters. The first chapter is the introductory chapter providing the introduction and background information about the study, the problem statement, the study objectives and the research hypothesis. In the second chapter, the relevant concepts and theories are briefly explained, and previous studies conducted in SISs in similar issues are reviewed and presented. The third chapter elaborates on the assessment of the institutional and organisational arrangements of water management in SISs. Chapter four looks at the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs. While the fifth chapter dwells on the investigation of the effects of governance on cropland allocation decisions in SISs. Concluding remarks, the study recommendations and highlights areas for future research are presented in chapter six.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter is a review of literature from prior studies conducted in SISs. It provides an overview of SISs in SA, their performance and the challenges they face. It reviews water governance dimensions in SISs, gender and intergenerational involvement in irrigated agriculture as well as issues regarding resource distribution across women and youth.

2.2 An Overview of Smallholder Irrigation Schemes in South Africa

Smallholder irrigation schemes are generally defined based on their water diversion and irrigation systems. According to Gomo (2012: 3), smallholder irrigation involves the diversion of water from a natural source into a relatively small area for a purpose of supplementing available water for crops. Smallholder irrigators divert water using gravity-fed canals, pipes, weirs or water pumps for application in the fields through various irrigation methods (Food and Agriculture Organization of United Nations (FAO), 2001). Denison & Manona (2007); Van Averbeke *et al.* (2011) and Fanadzo (2012) defined SIS as an irrigation scheme developed in the former homelands specifically for disadvantaged farmers in a resource-deprived area. Smallholders are often located in the former homelands and usually operate in relatively small plots (less than 5 ha). In addition, Van Averbeke (2008) and Fanadzo (2012) categorized smallholder irrigators into four groups, namely, farmers on irrigation schemes; independent irrigation farmers; community gardeners; and home gardeners. This study focuses on farmers on irrigation schemes.

In SA, SISs were developed during the colonial era in the 19th century with an intention to provide rural families with a livelihood from farming (Van Averbeke, 2008). All SISs developed during this era were canal schemes, however, the level of irrigation technology has improved throughout the years and became complex and costly. This was reflected by a shift from the use of canals towards different forms of water and labour-saving overhead irrigation systems, which continued until the democratization of the country (Muchara, 2014). In 1997, Backeberg and colleagues reported that about 54.4, 32.8 and 11.8 percent of the total irrigated land in SA used sprinkler, flood and micro-irrigation technology, respectively (Backeberge, 1997). The numbers increased, Fanadzo & Ncube (2018) reported 170, 101 and 25 known SISs that use overhead, flood and micro-irrigation technology, respectively. Among the irrigation

technologies used, micro-irrigation had the highest technical efficiency levels, followed by the sprinkler, while flood irrigation had the lowest (Backeberg, 1997).

Since the establishment of SISs, irrigation management had been the primary responsibility of government or its agencies until the Irrigation Management Transfer (IMT) era in the late 1990s. During the IMT era the irrigation management, operational and maintenance responsibility was transferred from the state to farmers in a manner that maximizes the chances of self-sustainability and growth (Van Averbeke, 2008). The process entails transferring water rights from being state-owned to market-oriented water rights (tradeable), withdrawal of government support from SISs, etc (Backeberge, 1997). According to Backeberge (1997); Shah *et al*. (2002) and Machete *et al*. (2004), IMT was initiated as a strategy to improve scheme management performance, increase the profitability of irrigated agriculture, increase accountability of water users, encourage farmers to take responsibility for water resource management with limited government assistance, to improve farmer willingness to pay for the operation and maintenance costs and mostly to reduce recurrent public spending on operation and maintenance of the schemes.

Currently, SISs are under local responsibility, they are managed and operated by farmers. However, farmer-managed SISs showed weak regulatory and water management instruments, poor rule enforcement mechanisms, lack secured property rights and lack reliable water supply (Muchara, 2014). As such, some irrigation schemes collapsed, while others faced management and sustainability challenge, especially the large schemes with modern irrigation technology as they incur high infrastructure maintenance costs (Van Averbeke, 2011). The Tomlinson Commission (1955) cited by Van Averbeke (2012) reported that state-owned irrigation schemes performed better than farmer-owned irrigation schemes. This is because the state imposed the institutional arrangements regulating the allocation of water to farmers and land use, including choice of crops, and the provision of technical advice and marketing assistance for the crops that were prescribed to farmers. Farmers experienced several challenges in accessing essential services (such as inputs, credit, output market, etc) but the major challenges were high costs due to mechanization, high electricity costs and the repair of the breakdown of the old pumps.

Van Averbeke *et al.* (2011) counted 302 SISs in SA with 206 (68%) operational, 90 (30%) non-operational and 6 (2%) missing schemes. Table 1 provides a summary of SISs, both functional and dysfunctional in SA. Among the non-operational, irrigation schemes using

overhead irrigation technology constituted the largest proportion (59%) because the irrigation infrastructure was complex and costly to manage (Fanadzo & Ncube, 2018).

Table 1. Smallholder irrigation schemes in South Africa by province

Province	**Total SISs in SA**	**Number of operational schemes**	**Number of non-operational schemes**	**Number of unknown schemes**
Limpopo	170	101	69	0
Mpumalanga	9	7	2	0
North West	2	2	0	0
KwaZulu-Natal	36	35	0	1
Free State	2	1	1	0
Northern cape	3	2	1	0
Eastern Cape	72	51	16	5
Western Cape	8	7	1	0
Total	**302**	**206**	**90**	**6**

Source: Van Averbeke *et al*. (2011); Fanadzo & Ncube (2018)

2.3 Challenges Faced by Smallholder Irrigation Schemes

Smallholder farmers experience several challenges limiting them from performing at satisfactory levels. Common challenges faced include insecure land tenure, lack of farmer training and extension support services, lack of access to credit, lack of access to markets, lack of financial resources, collective management of resources, etc (Mudau, 2010; Van Averbeke *et al*., 2011; Muchara, 2014; Muchara *et al.*, 2014; Mvelase, 2016). The government managed to address technical challenges by investing in the revitalization of SISs, upgrading irrigation infrastructure and improving resource management techniques. Efforts have also been made to address the other challenges, although they have not been successful. Farmers have not reached their target production and income. The next paragraphs elaborate on these challenges.

Insecure land tenure: Although smallholder farmers can access agricultural land from traditional authorities, they are not granted exclusive land rights, only the Permission to Occupy (PTO) certificate (Mudau, 2010; Veldwisch, 2013; Fanadzo & Ncube, 2018). Farmers who occupy leased land live in fear that they might not be allocated similar plots when the lease

agreement expires (Cousins, 2012). According to Shah *et al*. (2002) and Mvelase (2016), land rights are one of the major constraints in the performance of farmers in their plots and management practices they adopt. With insecure land tenure status, it is impossible for farmers to make long term investments in their plots and to use the plot held as a source of collateral to secure credit from formal institutions (Shah *et al.*, 2002).

Access to credit: Access to credit is imperative for farmers with insufficient finances as it enables them to purchase necessary inputs and to make an investment in technologies that can improve their productivity (Bembridge, 2000). However, due to their inability to use their allocated land as collateral which comes in the form of land rights that most farmers do not possess, they are not granted credit (Machete *et al.,* 2004). Financial institutions perceive smallholder farmers to be associated with high risk and give first preference to large-scale farmers (Mvelase, 2016).

Marketing issues: Market access has been recognized as the main driving force of agricultural commercialization and one of the drivers of successful smallholder farming (Magingxa *et al*., 2006). Farmers in SISs find it difficult to secure a contract with reliable and stable markets where they can sell their fresh produce due to low bargaining power, high transaction costs, poor linkages to important inputs and output markets, etc (Mvelase, 2016). As a result, smallholder farmers have limited opportunity to earn more from their sales and to create opportunities for rural employment.

Training and Extension support services: Extension advisory and agricultural support services can have a large impact on productivity improvement and development of SISs (Fanadzo *et al.,* 2012). However, capacity building and farmer training in scheme management have been the missing links in SA, and failure of many SISs have been attributed to lack of adequately trained farmers and extension staff (Fanadzo & Ncube, 2018). Most farmers in SISs are not well informed with recent land preparation, crop production techniques, irrigation scheduling, and water management as well as with technical matters pertaining to irrigation infrastructure (Mvelase, 2016). They still rely on indigenous knowledge (Muchara, 2014). The Department of Agriculture (2005) cited in Fanadzo & Ncube (2018) reported the ratio of extension from the neighbouring countries as India (1:1000), Zambia (1:800) and Zimbabwe (1:700) indicating that the available extension officers are too little for the smallholders.

Collective management of resources: The joint management of communal resources such as irrigation water and irrigation infrastructure are challenging tasks for most smallholder irrigators and a primary source of conflicts among irrigators within the scheme. The absence of property right makes it difficult to exclude nonscheme members from utilizing the scheme water (Muchara, 2004). This is a common issue in irrigation schemes since households are located along the river or the canal. For example, the quantity or the quality of water for downstream users can be affected by the activities of upstream users (Faysse, 2004).

2.4 Water Governance Dimensions for Irrigated Agriculture in South Africa

Many researchers view the concept of water governance differently. Shah *et al*. (2015) defined water governance as an interplay between water laws, policies and institutions affecting water economy. It is also concerned with the processes involved in formulating and enforcing rules in the water sector. Van Koppen (2002) defined institutions as the collective arrangements governing the construction and operation and maintenance of irrigation infrastructure, water distribution and resource mobilization can be formal or informal. While formal institutions are written laws, rules and procedures, informal institutions are established procedures, norms, practices and patterns of behaviour; they may be created or evolve over time (North, 1990; Nhundu, 2013). Institutions affecting irrigation are not only those directly managing it. There are other governance aspects such as political, economic, organizational structures and social interactions and are considered as not mutually exclusive (Bandaragoda & Firdousi, 1992; Nhundu, 2013). According to Lestoalo & Van Averbeke (2006), institutional inefficiencies and weaknesses lead to shortages, inequitable distribution of water and negatively impact on the maintenance of infrastructure. The limited availability of land and water resources increase the need for clearly defined property rights and institutions on how these resources are distributed and used productively, as it is widely known that property rights provide an incentive for efficient use of scarce resources (Jonckheere & Liversage, 2017). The existing SA legal understanding of water use and the ownership of land, without access to land, individuals cannot access irrigation water (Tsur, 2010).

2.4.1 Formal institutions

Water resource in SA is regulated by water legislation accompanied by government strategies to ensure that the aims of the central water law are achieved, as well as the informal rules and

regulations at the local level (Visser, 2015). Its allocation is through authorization (licensing and registration) to avoid and control the risks of unsustainability in its management (Namara *et al.*, 2010). Water sector has been undergoing several transitions since the apartheid government to a democratic government (Perret, 2002). Following the democratization of SA in 1994, the government abolished water laws established during the apartheid era and adopted new water policies, strategies, programmes and organizational structures to address the imbalances of the past (Fanadzo & Ncube, 2018). The Irrigation and Water Conservation Act (Act 8 of 1912) and Water Act (Act 54 of 1956) were abolished because they served the interests of the white minority and resulted in commercial white farmers having unconstrained water access (Perret, 2002; Tewari, 2009). Among the newly established water legislation were the National Water Act (1998), National Water Resources Strategy (2013), Water Allocation Reform (2006), Irrigation Strategy (2015), Catchment Management Agency and Water Users Association along with informal rules and cultural norms at the local level.

2.4.1.1 Water policies and laws

National Water Policy (1997): The National Water Policy treats water as an economic good, and for the protection, use, development, conservation, management and control of SA's water resources (Karodia & Weston, 2001). This policy redefined the ownership and allocation of water and affirms that all water is public water and that the national government will act as a public trustee (Folifac, 2007).

National Water Act (NWA) (Act 36 of 1998): The NWA was developed and implemented to ensure that SA's water resources were protected, used, developed, conserved, managed and controlled. The Act has three key principles; sustainability, equity and efficiency, guiding the protection, use, development, conservation, management and control of water resources (Republic of South Africa (RSA), 1998). The sustainability principle promotes social and economic development and ensures that the environment is protected for future use. The equity principle ensures that everyone has equitable access to water, and the water allocation decisions are fair to all people. While the efficiency principle ensures that water used is not to be wasted. To achieve the aims of NWA, the Act created two user-driven water resource management organizations, which is, the catchment management agency at catchment level and water user's association at the local level and allowed users to participate in decision making by decentralization water management to catchment and local levels. Backeberg (1997) also

indicated that participation of water users in water management can be achieved by establishing organizations representing their interest on a local level. The NWA authorizes smallholder farmers to abstract water for irrigation without registration, licencing or payment as stipulated in Schedule 1 of the Act (Perret, 2002). The National Water Policy requires water users to join water user's associations, to register as water users through licencing, to apply for water rights and pay application and user fees (Sokile *et al.*, 2005).

2.4.1.2 Strategies for water and irrigation

National Water Resource Strategy 2 (2013): The second edition of Natural Water Resource Strategy (NWRS) established in 2014 describes how water resources will be used and protected according to the requirements of existing policies and laws (Department of Water Affairs and Forestry (DWAF), 2004). While the second edition implemented in 2013 provides a framework for the protection, use, development, conservation, management and control of water resources for the country. The NWRS2 sets out the strategies to plan, develop, manage, protect and control the use of the nation's water resources effectively for the future (Department of Water Affairs (DWA), 2013). The NWRS2 responds to the priorities set by the government within the National Development Plan (NDP) and the NWA for sustainable development. The NDP and NWA collectively embarked towards equitable water allocation to redress the past racial imbalances. The SA constitution states that water resource is a basic human need for the current and future generation (RSA, 1998). Hence, equitable access to water resources is imperative for poverty alleviation and the promotion of equitable and sustainable growth. According to DWA (2013), equity and redistribution can be achieved through the authorisation process and other mechanisms such as Water Allocation Reform (WAR) programme which was developed to ensure that the main objectives of the NWRS are all met.

Irrigation Strategy: The Irrigation water strategy for SA was informed by the NDP and the NWRS2. The strategy was developed as a response to the call for the agricultural sector to increase its contribution to agricultural production thus ensuring food security, poverty alleviation and job creation (DAFF, 2015). It seeks to support irrigation initiatives based on the revitalisation of irrigation schemes, development of new irrigation schemes, as well as management and efficient use of water for irrigation purposes. The irrigation strategy had several objectives such as increasing the contribution of irrigated agriculture to the GDP (at least in absolute terms), poverty alleviation, creation of employment and skills development; increase equitable access to irrigated agriculture by historically disadvantaged individuals

(HDIs), especially commercial irrigated agriculture, without compromising irrigation water use efficiency in the process and to optimize irrigation water use efficiency with a view to long-term sustainability of irrigated agriculture (DAFF, 2015).

2.4.1.3 Government programmes

Some of the programmes included revitalisation of smallholder irrigation schemes programmes, WAR and the land reform (Fanadzo & Ncube, 2018).

The Revitalisation of Smallholder Irrigation Schemes (RESIS): The RESIS programme was developed in 1998 to improve agricultural productivity on the schemes; to enable the schemes to play a role in local economic development through improved incomes for beneficiaries, and to improve food security (Maepa *et al.*, 2014). To achieve these objectives, the RESIS programme revitalizes selected smallholder irrigation schemes with outdated irrigation technologies/ infrastructure in Limpopo province (Veldwisch, 2013; Maepa *et al.*, 2014). Under the RESIS programme in (1998 – 2001) in Limpopo, the scheme infrastructure was rehabilitated, irrigators were provided training on field and system water management and the management of the scheme was handed over to the water users association (Veldwisch, 2013). Moreover, the RESIS programme had positive outcomes at the Thabina irrigation scheme. After the revitalisation of the scheme, the Management Committee (MC) became the legal management body, water availability was significantly increased, and the yields were significantly increased (Veldwisch, 2013).

Land Reform: The distribution of water resources in SA had been extremely unequal across different racial groups with whites accounting for only 0.5% of the total population yet controlling at least 95% of the water resources (Van Koppen, 2008). The Africans had been historically disadvantaged not only in the water sector but also with regards to land ownership. The HDIs did not have water entitlement in their names. According to Van Koppen (2008: 433), "the Land Act of 1913 'lawfully' dispossessed Africans of 91% of their land, slightly limiting to 87% under the Land Act of 1936". As such, a large proportion (87%) of the total available land was controlled and owned by the White minority. Furthermore, land dispossession aggravated the situation even further, causing a highly unequal pattern of land ownership and widespread rural poverty in SA (Jacobs *et al.*, 2003). In 1998, Oettle and colleagues reported that the white minority (60 000 white commercial farmers) occupied about 102 million ha while the black majority (1.2 million black farmers) occupied only 17 million ha of agricultural land (Moswetsi *et al.*, 2017). This reflects racial imbalances in land

distribution. According to Links (2011), these imbalances are not new, by 1958 there was already a need for land reform in SA as the Black people were not given equal opportunities as white people and therefore were forced off farmland and properties.

Following democratization of the country, the SA government implemented the land reform programme which constitutes three dimensions: redistribution, restitution and land tenure reform (Cliffe, 2000). According to Jacobs *et al.* (2003: 1) and Cliffe (2000: 274 – 275), land restitution deals specifically with historical rights in land. aims to restore to those dispossessed of their rights in the land since 1913 through racially discriminatory laws and practice. Land tenure reform with forms of landholding. It seeks to address issues pertaining to insecure, overlapping and disputed land rights resulting from the previous systems of governance, especially in the former Bantustans. Land redistribution is specifically aimed at transforming the racial pattern of land ownership. The key target was to redistribute 30% of white-owned commercial farmland by 2014 (Links, 2011).

The overall status of the land reform programme in SA is considered as slow and not meeting government targets (Links, 2011). The total number of beneficiaries from the land redistribution has been increasing from 1994 (1 004) up to 2000 (34 768) and most land transfers occurred in the Northern Cape and KwaZulu-Natal province (Jacobs *et al.*, 2003). In 2001 and 2002 the numbers declined. Links (2011) reported that only 5% of the land was redistributed by 2008. According to Links (2011), less than 2% of SA farmland was redistributed by 1999 and only 7 % of the land out of 30% has been transferred and redistributed to 2011. With regards to land restitution, only a few claims had been successfully resolved by 2000 (Cliffe, 2000). The tenure reform process was complex and slow. In 2013 about 1556 cases were resolved while in 2009 the number declined to 405 (Links, 2011).

Water Allocation Reform: The DWA established the WAR to redress past imbalances (racial and gender) in the allocation of water. It reallocates water from the advantaged to economically disadvantaged individuals, regardless of the linkage between water and land. The WAR programme aims to take steps to meet the water needs of HDIs and the poor, ensure participation by these groups in water resource management, promote the sustainable use of water resources, and promote the beneficial and efficient use of water in the public interest. However, the WAR programme has not covered its entire scope, for example, the compulsory licensing has not been widely implemented.

2.4.1.4 Organizational structures

Catchment Management Agency (CMA): CMAs are regional water management institutions established to manage water resources at catchment level as well as to perform the key responsibilities of NWA at catchment level. According to Karodia & Weston (2001: 16), the key functions of the CMA included playing a coordinating role regarding water-related activities and water management institutions; developing and implementing a Catchment Management Strategy; and encouraging public participation. In SA, the implementation of CMA has not been successful. Bourblanc & Blanchon (2014) reported that there were only two CMAs that had been established, among reasons that contribute to the failure of CMAs include poor administration, mismanagement, lack of training of newly appointed public servants or coordination problems.

Water Users Association (WUA): WUAs are local water management institutions established to enable people within a community to pool their resources to carry out water-related activities more effectively as well as to take over irrigation management functions such as water allocation and distribution, water charging system, irrigation maintenance, financial management, and redressing racial imbalances of the past created by Irrigation Boards and the individual rights principle. (Karodia & Weston, 2001; Perret, 2006). The significance of WUAs in improving water management, conflict resolution, improved fee collection, enhanced land productivity and resulting in better operation and management have been recognized in Africa (Shah *et al.*, 2002). However, the establishment of WUAs in SA has relatively slow. According to Saruchera (2008), all WUAs in SA were supposed to be formed by 2006, all irrigators had to join WUAs and the membership was meant to be compulsory. Still, the adoption of WUAs is very poor because its role has never been conceptualized nor fully defined to smallholder irrigators from the onset, lack of legal water rights among smallholder irrigators was another reason for not participating in WUAs.

2.4.2 Informal institutions

The behaviour and actions of farmers towards land and water resources cannot only be determined by the statutory rules and procedures, but also informal rules, customs and traditional practices play an important role in governing organizational and social behaviour (Bandaragoda & Firdousi, 1992). Farmers at scheme level tend to devise their own rules, procedures and regulations from statutory laws that best represent their interest such as local

norms, customary laws and religious laws (Namara *et al.*, 2010). Local norms play a significant role in ensuring equitable access to water for both domestic and production purposes among all persons in the area. Although informal rules have similar intentions (equity and sustainable management of water resources) and resolutions in water management as statutory laws, they tend to be unnoticed by official policies and intervention strategies (Namara *et al*., 2010).

Irrigators in irrigation schemes elect the scheme committee which acts as water management institution and oversees all the irrigation management activities in the scheme (Bandaragoda & Firdousi, 1992). As for water management, most irrigation schemes develop an irrigation arrangement whereby all irrigators have an equal chance to access irrigation water. Rotational irrigation is often practised when water stresses are high and to ensure that all farmers may receive enough water to irrigate their fields and it was recognised as a successful case of formalized informal arrangement for water management (Sokile *et al.*, 2005; Deribe, 2008). Although both formal and informal water institutions are equally important in managing water at scheme level, informal institutional arrangements (customary institutions) and local institutions tend to be more valuable, influential and powerful compared to formal institutions due to low diffusion of the state laws and irrigators have an incentive to follow and enforce rules formulated by themselves than those handed down from an outside authority (Tang & Ostrom, 1993; Sokile *et al*., 2005; Deribe 2008). According to Bandaragoda & Firdousi (1992), informal institutions attract greater compliance from individuals and groups because they seem to be more relevant to the needs of the locals.

2.5 Youth in Irrigated Agriculture

Youth is regarded as the basic resource of the country, the future of the agricultural sector and the most productive proportion of the total labour force (Mousaei & Arayesh, 2011). Yet, their involvement in the agricultural sector is disappointing and has been as declining over the past few years, let alone participation in SISs (Cheteni, 2017). This makes the future of agriculture looks uninviting as it is dominated by aged subsistence farmers. According to the National Youth Commission Act (1996) and the National Youth Policy (2000) cited by Mkra (2014), youth refers to young people who fall between the age-range of 14 to 35. Like in other developing countries, youth make the largest proportion (36.03%) of the total SA population (Statistics South Africa (Stats SA), 2017), yet they are reluctant to engage in agricultural activities and considering agriculture as their main careers. People in Centane rural community believe that government is not doing enough in providing support to stimulate youth

involvement in agriculture, national policies as well do not make agriculture attractive to the youth. Stakeholders from relevant government departments also acknowledged that the government was not providing sufficient support to encourage youth's involvement in agriculture (Mkra, 2014).

In the Eastern Cape Province, Mkra (2014) reported that the reluctance of youth to participate in agriculture was due to the following reasons:

i) young people lack encouragement and motivation from the people that do take farming seriously;
ii) youth believe that agriculture is time-consuming;
iii) youth are lazy, and they do not want to pursue things on their own, they expect the government to hand them things that are of benefit to them;
iv) they have a negative perception about agriculture and still view it as working on farm physically;
v) some believe that the agricultural sector is for the elderly, illiterates or people with nothing to do; and
vi) the youth want money, they want to do work that will provide them with a salary at the end of the month.

Some believe that agriculture is a low-status job associated with low wages. Hence, they tend to migrate to urban areas in search of better-paying jobs that will guarantee finances at the end of the month and as an alternative source of livelihood (Cheteni, 2017). Samardick *et al.* (2000) believe that local youth have low self-esteem which increases the negative perception about agriculture and thus, leads to non-participation.

It is also important to note that it is not always the negative perceptions of agriculture that impedes youth's participation in agriculture. Adekunle (2009) pointed out inadequate credit facility, lack of agricultural insurance, poor returns to agricultural investment, lack of basic farming knowledge and lack of access to farm inputs as some of the major constraints hindering youth participation in agriculture in Nigeria. In SA and Ethiopia, lack of access to productive land is a major limitation to the participation of youth in agriculture since land is not readily available for young people. Youth generally acquire land through inheritance, gift or borrowing from neighbours or informal rental markets, they do not hold land rights for the piece of land they are cultivating. The absence of land markets in rural Africa also contributes to difficulties

in land accessibility by young people and landless households (Kosec *et al.*, 2017). This results in youth migration to urban areas for high-return non-agricultural activities (Ibid.).

2.6 Gender distribution in Irrigated Agriculture

In agriculture, gender is often associated with women. Sociologists define gender as the roles and expectations attributed to men and women in a given society, and these roles can change over time and life stage (Phillips, 2005). Phillips (2005) also differentiated gender from sex, which is the biological difference between females and males. This study refers gender to women and men. According to Gender and Water Alliance (GWA) (2003), the effects of water scarcity differs across gender dimensions, and this could be associated with gender imbalances that have been noted in developing countries (Denison & Manona, 2007). Previous work done by the World Bank in Kenya revealed that women contributed approximately 80% labour to food production, managed 40% of smallholder farms, yet they held less than 10% of the registered titles, receive less than 10% agricultural credit and 5% agricultural extension services globally (Njie, 2013). In addition, women are also regarded as primary users of water resources, for both domestic and agricultural purposes. However, their participation in water management, decision-making positions and participation in scheme leadership is limited (Were *et al.*, 2008; Diiro *et al.*, 2018). Similarly, the membership of women in WUAs has been found to be limited in developing countries. In Kyrgyzstan, only 18% of women were recorded as WUA members in 2009 (Nixon, 2017). Were *et al.* (2008) attributed this to socioeconomic and governance factors. In rural areas, cultural/social norms play a significant role in dictating gender roles in society and often prevent women from participating in community organizations (Nixon, 2017). For example, men traditionally engage in public and community activities, while women are expected to do homestead activities and working as unpaid labour in their husband's land, (Panda, 2007; Were *et al.*, 2008).

Among the initiatives established to redress gender imbalances in the water sector, GWA was also established for similar purposes. It looks at whether the implemented water legislation, policies and programmes respond to gender messages (GWA, 2003). The literature argues that inclusion of women in resource governance promotes gender equity, reduces high dependency on men and improves their status in the community and households as decision makers (Nixon, 2017). The SA government through the equity principle in the NWA recognizes the importance of women's voices in water management structures. It is believed that fair distribution of resources and equal participation of women in water management and giving them a voice in

decisions on use and allocation of water resources could improve their status (Mjoli *et al*., 2009). Moreover, the involvement of women in water resource development has been recognised as having the potential to lead to designing effective new solutions to water problems; making irrigation schemes more sustainable; ensuring that infrastructure development yields the maximum social and economic returns; etc (Panda, 2007). For example, after changing the structure of the water committee in Malawi and Philippines to electing at least 60% women in the committee, the management of water points improved significantly. Irrigation bills were paid on time, meetings were held consistently, membership and attendance also improved.

The SA land reform prioritises racial inequalities in land ownership as the main source of inequity while giving minor attention to gender and generational dynamics (Nyamwanza, 2017). The African norms of land inheritance also favour males, as it is only the sons who have stronger chances of inheriting land when the parents pass on (Dushimimana, 2007; Kosec *et al*., 2017). Women and daughters cannot access land on their own, they depend on their husbands and male kins (Arends, 2009). Under customary law, the land is generally allocated to men, the household heads. The intentions of the country NDP (2012) to create one million jobs by 2030 through agriculture cannot be met if youth land rights are not enhanced (Nyamwanza, 2017). The land restitution of the land reform programme is the only government programme that can assist youth to obtain beneficiary control and ownership of land for farming and agricultural purposes as its arguments for enhancing youth land rights (Nyamwanza, 2017).

2.7 Land Utilization in Winter Season

The severity of water scarcity has negative implications for cropland utilization. In countries like West Bengal and coastal Bangladesh characterised by dry winter seasons, they often fallow their land due to the inadequate water supply for cropping (Krupnik *et al.,* 2017). This was also evident in SISs in Limpopo where Van Koppen *et al*. (2017) reported high non-utilisation of SISs in winter. Of the study irrigation schemes, 36% were found to be fully utilized during the 2015 winter irrigation season, 36% were not utilized and the utilization of 29% schemes was low or moderate. Among the irrigated land equipped with centre pivots about 69% of the area was not used. In the study conducted in Zanyokwe irrigation scheme, it was found that not all irrigators cultivated all their plots during the winter season. About 24% irrigator who utilised their total land holding while the rest partially cultivated their land. Interestingly, no single

irrigator left their land idle (Tshuma & Monde, 2012). This was a major improvement on the level of land use in the scheme brought by the Best Management Practices Project. According to Van Koppen *et al*. (2017), some causes of poor status of infrastructure and low utilization are associated with institutional and social issues such as land tenure security, scheme management practices (water distribution, maintenance, etc) and intra-household and intra-community relations. While, irrigators pointed out that water infrastructure and water availability were the key limitations for full utilization of irrigated land followed by the lack of implements for land preparation (Van Koppen *et al.,* 2017).

2.8 Summary

The SA government established SISs during the colonial era to alleviate poverty and improve food security in rural families through irrigated agriculture. However, there has been widespread concern about the poor performance of SISs partly because of the common challenges facing smallholder farmers with poor governance problems and weak institutional arrangements being the key ones that have been overlooked. In the late 1990s, the government transferred irrigation and scheme management to irrigators with an intention to improve smallholder performance, reduce government spending, etc. Financial investments were also made in refurbishing irrigation infrastructure with an intention to improve smallholder contribution in the SA economy. However, poor performance among SISs is still persistent. The government implemented the NWA, NWRS and programmes to ensure that SA's water resources are protected, used, developed, conserved, managed and controlled. Unequal representation of gender and intergenerational dimensions in water management and decision-making positions, and unequal distribution of land resource across the dimensions have been noted. This has resulted in discrepancies in resource allocation and utilization and in agricultural productivity before taking into account the level of governance understanding. Both the statutory land and water policies have not succeeded in addressing these inequalities.

CHAPTER THREE: DESCRIPTION OF INSTITUTIONAL AND ORGANISATIONAL ARRANGEMENTS FOR WATER MANAGEMENT IN SMALLHOLDER IRRIGATION SCHEMES IN KWAZULU-NATAL, SOUTH AFRICA

Abstract

Smallholder irrigation schemes in South Africa were established for improving rural livelihoods and to alleviate poverty through effective and equitable use of land and water resources among rural communities. However, achieving a fair distribution of these resources has been challenging in most developing countries due to management challenges. The literature points out that smallholder irrigation schemes cannot reach the expected outcomes without basic institutional reform for irrigation management. This study applied descriptive statistical techniques to describe institutional and organisational arrangements for water management in Mooi River, Tugela Ferry and Ndumo irrigation schemes in KwaZulu-Natal Province, South Africa. The results indicated that irrigation schemes had functional informal institutions governing the use and management of water resources. All the schemes had the committee facilitating the scheme management activities. Therefore, the study recommends that smallholder irrigators in other irrigation schemes should be encouraged to take all the scheme matters to their own hands since the smallholder irrigation schemes are in the irrigation management transfer era.

3.1 Introduction

The global decline in water supply has imposed a considerable threat to rural households whose livelihood heavily depends on agriculture since water plays a pivotal role in enhanced livelihoods and rural development (Patel *et al*., 2014). Irrigation has, therefore, become an alternative to sustain agricultural production due to its direct impacts on improving farmers' livelihood and alleviating poverty (Wang, 2011). The key aims of adopting and establishing SISs can be achieved through effective and equitable use of land and water resources among rural communities (Dejene *et al*., 2008). However, achieving a fair distribution of these resources presents challenged in most developing countries. For example, in western Oromia, Ethiopia there were claims that land ownership, the distribution of farm sizes and irrigation water was not fair among irrigators (Dejene *et al*., 2008). Farmers with higher income levels had relatively bigger plots while about 20% irrigators did not own land and could only access

it through sharecropping (leasing-in and leasing-out), labour exchange and exchange of oxen for land. Management difficulties were also exacerbated by an insecure land tenure which made it difficult to clearly know the total amount of irrigable land used by irrigators and thus, to adjust water allocation and resource mobilization among irrigators (Dejene *et al*., 2008).

Prior to the Irrigation Management Transfer (IMT), the government developed and imposed institutions and organisations governing SISs without the input of farmers and provided them with free services (Letsoalo & Van Averbeke, 2005; Mutambara *et al.,* 2014). However, the government-managed irrigation schemes experienced various challenges with the management of water resources which resulted in inadequate distribution of water, the inadequate allocation for operation and maintenance. Irrigators had no incentives to save water. As a result, the performance of irrigated agriculture fell below technical and economic potential (Boyer, 2007). Studies on water governance in SISs showed that water governance-related services especially operating rules, rules enforcement, and sharing responsibilities among members are better provided by the irrigators themselves and are more efficient and effective in farmer-managed irrigation schemes (World Bank, 1998; Frederiksen & Vissia, 1998; Ostrom, 1992 & 2002; Bromley, 1992 cited by Boyer, 2007). Unfortunately, farmers could not manage the scheme on their own following decentralization due to lack of financial resources, lack of managerial skills, etc. As a result, most irrigation schemes have been declared unsustainable and dysfunctional (Letsoalo & Van Averbeke, 2005; Mutambara *et al.,* 2014). Moreover, claims of poor management of water resources persist.

Makombe *et al.* (1998) pointed out that water management is a common challenge across smallholder crop production as farmers often fail to equate water supply and demand and the appropriate time of water application. According to Schaible & Aillery (2007), irrigation water management is a practice of controlling the use of irrigation water and related inputs to maximise economic return from irrigated crop production while minimising environmental impacts. It involves scheduling how much water to be abstracted and when to irrigate. Simitu & Odira (2007) noted inefficient water resource usage from irrigation as irrigators often apply water regardless of crop growth stage and water requirement resulting in overirrigation or under irrigation. According to Speelman *et al.* (2010), the lack of effective water rights systems, water charge system and ill-defined property rights are the major sources of low water use efficiency and major problems for the water management in SISs around SA. Bromely (1992) cited by Wang (2011) argued that water availability is not much of a problem, the real problem is rather

the absence of effective management regimes. Samakande *et al*. (2002) also inferred that SISs cannot reach the expected outcomes without basic institutional reform for irrigation management.

This study describes institutional and organisational arrangements for water management in Mooi River, Tugela Ferry and Ndumo irrigation schemes in KwaZulu-Natal Province, South Africa. This chapter is organised as follows: the first section introduced and provided general background about the study; the second section outlines the methodology used to achieve the objective of this study; the fourth section discusses the key findings while the last section summarises the conclusions and provide the study recommendations.

3.2 Methodology

This section provides the research methods used in this study, briefly explaining the conceptual framework, study area, sampling and data collection techniques, data analysis method used in this study.

3.2.1 Conceptual framework

Irrigation schemes constitute irrigators interacting with the water resource system and governance system governing the use and management of the resources. Irrigators within the SISs share water resource, irrigation infrastructure and water distribution system to achieve individual goals. The fact that irrigation water utilised in irrigation schemes is shared by a community of users and its characteristics of non-excludability and subtractability makes it a common resource (Boyer, 2007; Wang, 2011; Anaba, 2016). The amount of water used by one irrigator is no longer available to other irrigators using the same water resource (Anaba, 2016). Moreover, excluding others (non-irrigators) from benefiting from irrigation water is relatively difficult and costly since ownership rights are not assigned to anyone (Wang, 2011). This makes it challenging to effectively manage irrigation water.

Water governance dimensions (water policy framework, organisations and rules and regulations) established from formal or informal structures assist in the management of water resources. Irrigators within the scheme interact with the established water institutions to ensure that water resources are equitably distributed across the scheme and used in a sustainable manner. However, there are sufficient conditions (such as the Ostrom's eight design principles)

essential for effective management of common property resource (CPR). Ostrom (1990) cited by Samakande *et al*. (2002); Muchara (2014) identified eight design principles that can prevent over-exploitation and lead to successful self-government of the CPR. These design principles have often been used to analyse institutional arrangements in SISs. The institutional design principles on an irrigation management deal with the appropriation and provision problems and serve as sufficient conditions for fair allocation of the resource (Muchara, 2014).

Ostrom (1990) defined the eight design principles describing the CPR institutions as follows;

- Clearly defined boundaries: clearly defined boundaries in the form of rights to withdraw resource can prevent the depletion of CPR and ensure that benefits from the CPR enjoyed by the right holders.
- Congruence between appropriation and provision rules and local conditions: "appropriation rules restricting time, place, technology, and quantity of resource units are related to local conditions and provide of rules requiring labour, material and/ or money" (Samakande *et al*., 2002: 2). The rules set at different levels should align.
- Collective choice arrangements: beneficiaries of the CPR users affected by the operational rules can participate in amending the operational rules.
- Monitoring: rule enforcement and appropriate behaviour can be achieved when there are monitors who actively audit CPR conditions.
- Graduated sanctions: users who violate the operational rules should face graduated sanctions depending on the seriousness and the context of the offence.
- Conflict resolution mechanisms: CPR users and their officials have access to low-cost local arenas to resolve conflicts (Samakande *et al*., 2002: 2).
- Minimal recognition of rights to organize: the external government authorities should recognise the rights and institutions devised by CPR user at the local level.
- Nested enterprises: appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises (Samakande *et al*., 2002: 2).

The interaction between irrigators and the governance system governing the use of resources within the scheme can have either positive or negative outcomes on water management, scheme performance or production decisions. However, the effects are not uniform since there

is heterogeneity among irrigators with regards to socio-economic attributes and resource endowment (Murugani & Thamaga-Chitja, 2018). The linkage between irrigators and governance system within irrigation schemes is depicted in Figure 1.

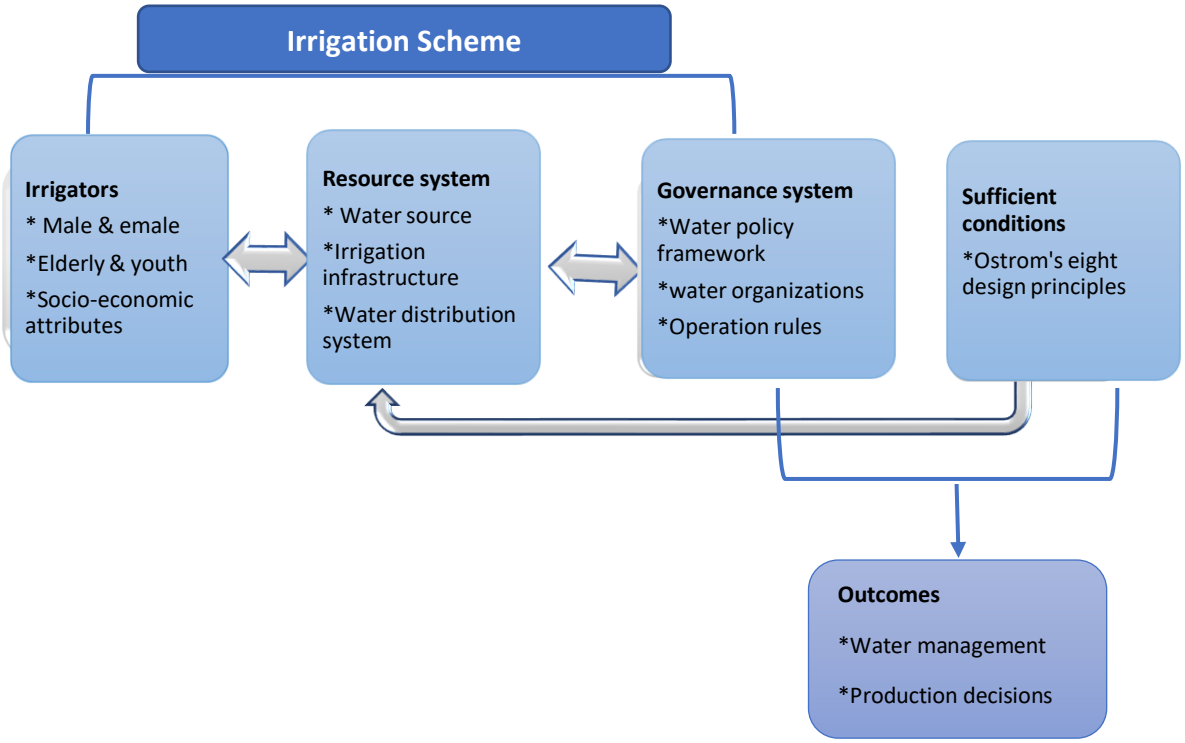

Figure 1. Linkage between irrigators and governance system within irrigation schemes

Source: Muchara (2014)

3.2.2 Study area

The survey was undertaken in Mooi River Irrigation Scheme (MRIS), Tugela Ferry Irrigation Scheme (TFIS) in Msinga Local Municipality in Umzinyathi District and Ndumo Irrigation Scheme (NIS) in Jozini Local Municipality in Umkhanyakude District. Msinga is largely rural areas with 70% of its land being held under traditional authority by Ingonyama trust and 30% of the remaining land is commercial farmland (Njoko & Mudhara, 2017). Likewise, a large proportion of Jozini area is predominantly rural with 60% of its land held under Ingonyama Trust ownership with four tribal authorities which are recognised as custodians of land (Jozini

Municipality, 2017). The remaining 40% of Jozini land surrounding the Pongola River is State-owned (Jozini Municipality, 2017).

Characteristics of the study irrigation schemes

MRIS: A farmer-managed irrigation scheme of approximately 600 ha made up of 15 blocks. The scheme serves about 850 irrigators. The scheme abstracts water from the Mooi River by gravity into a 20.8 km long main canal which further conveys water to the field (Nyiraneza, 2007; Njoko & Mudhara, 2017). The canal has several gates for different blocks, moreover, each block has few channel gates to direct the irrigation water from the main concrete canals along ground channels to the farmers' plots (Nyiraneza, 2007). The Mooi River Irrigation Scheme was established in the 20th century for improving the livelihood of people residing in Muden rather than for income generation (Chirigo, 2014).

TFIS: A farmer-managed irrigation scheme of approximately 800 ha made up of 7 blocks. The scheme serves about 1500 irrigators. The scheme is fed by Tugela River and uses the canal, diesel, and electric pumps to convey water to the field. The scheme was constructed in the early 20th century for improving the welfare of the people residing in the area (Cousin, 2012).

NIS: A farmer-managed irrigation scheme of approximately 1500 ha made comprising of Phase 1 and 2. The scheme serves about 100 irrigators. Farmers in Phase 2 operate as a cooperative (Mnothophansi Co-operative), although they work individually. The scheme is fed by Pongola River and uses an electric pump to convey water to the field. This is a new irrigation scheme established in March 2016.

Water conveyance system and irrigation technology differ across the schemes implying that water supply and accessibility also differ. Therefore, the inclusion of irrigation schemes from different parts of KwaZulu-Natal was meant to capture the variation in the availability and accessibility of water resources as well as capturing the full diversity of institutional arrangements since all these irrigation schemes are farmer-managed.

3.2.3 Data collection methods and sampling techniques

Primary data used in this study were collected through focus group discussions, key informant interviews and a structured household questionnaire. The household questionnaire was pre-tested, modified accordingly and administered by trained Zulu-speaking enumerators. To select survey respondents, a stratified and systematic random sampling technique was employed, where the strata were Blocks within the irrigation schemes. Irrigators were drawn from each

block within the scheme since the distance from the main canal differ across the blocks. This was done to ensure a sample representative of the population of irrigators. According to Cochran (1977) and Singh & Chaudhary (1986), stratified random sampling is the sampling technique whereby a sample is randomly drawn from nonoverlapping strata of the population. While, systematic sampling is defined as the sampling technique in which only the first unit is selected with the help of random numbers and the rest get selected automatically (Singh & Chaudhary, 1986: 81). This study combined both systematic and stratified random sampling technique because of their advantages. It is easier to draw more precise samples that are easy to execute with no mistakes with systematic sampling (Cochran, 1977). Stratification was incorporated to ensure adequate representation of various groups of the population (Singh & Chaudhary, 1986). A sample of 274 irrigators (11.18% of the population of irrigators) was drawn from the three irrigation schemes by selecting every fifth irrigator.

3.2.4 Analytical framework

This study, therefore, applied the descriptive statistical method such as frequency, percentage, mean, and standard deviation, χ^2-statistic, and presented in a table and graphical format, to analysed data obtained during household surveys, focus group discussions and key informant interviews. The descriptive statistical technique was chosen because of its suitability to quantify qualitative responses (Ott & Longnecker, 2001; Pe´rez-Vicentea & Expo´sito Ruizb, 2009). It is often used to describe any data set and draw a set of conclusions about the characteristics of the sample (Ott & Longnecker, 2001; Pe´rez-Vicentea & Expo´sito Ruizb, 2009).

3.3 Results and Discussion

This section discusses the institutional arrangements in the study irrigation schemes with more focus on activities carried out in the management of water resources. These activities include water distribution, irrigation infrastructure maintenance, collection of water fees, conflict resolution mechanism and stakeholder involvement in the scheme management.

3.3.1 Water authorization

Table 2 presents water authorization in the studied irrigation schemes. During focus group discussions, key informant interviews and feedback workshops the majority (65.8% and more) of irrigators revealed that they did not have legally recognised water rights and licences. Water rights were linked to the cultivated plot in the scheme. Without access to land, individuals could not access irrigation water. Moreover, farmers in the studied irrigation schemes were not paying for water resources but paid for water conveyance such as electricity or diesel for the water pump.

When asked about willingness to pay for water resources all irrigators in NIS indicated strong willingness while most irrigators in MRIS and TFIS were not willing to pay (Table 2), they strongly believe that water is a natural resource created by God and it does not belong to anyone. The statistically significant results imply that the variation in willingness to pay for water resources among farmers differ across irrigation schemes. For example, the strong willingness in NIS could be attributed to important recognition given to water as they farm for income generation. Moreover, they hope that paying will ensure reliable access to irrigation water supply. Fanadzo & Ncube (2018) inferred that smallholder irrigators are only prepared to pay for water resources only if they are assured reliable access to water for irrigation and other productive uses.

Table 2. Water authorization and training in the study irrigation schemes

Water authorization	Response	Irrigation Scheme			
		MRIS	TFIS	NIS	χ^2
Availability of water licence (%)	Agree	34.2	34.2	11.8	***
	Strongly Agree	5.0	0.0	5.9	
Availability of water rights (%)	Yes	71.7	75.8	36.4	***
Willingness to pay for water resource (%)	Yes	44.2	41.4	100.0	***

*Note: *** = p<0.01; ** = p <0.05; * = p<0.10 and NS= not statistically significant*

Source: Survey data (2018)

3.3.2 Scheme management

Following the irrigation management transfer, the government delegated all the irrigation management responsibilities to local management institutions, the WUAs. However, due to the nonexistence of WUAs in the study irrigation schemes, the scheme committee acts as water management organization and carry out all the management responsibilities. MRIS, TFIS and NIS are managed by the primary (Block level) and the secondary committee (scheme level), which performed the following responsibilities:

- ensures equitable water distribution among all irrigators in the blocks;
- enforcing rules and regulation of the scheme;
- inspecting irrigation infrastructure condition;
- planning, organising and enforcing farmer participation in irrigation infrastructure maintenance;
- organizing the canal cleaning and collecting funds for repairs;
- resolving water disputes in the scheme; and
- attending to complaints raised by irrigators.

The primary committee is democratically elected by scheme members while the secondary committee comprises of the chairpersons from different Blocks. However, the secondary committee is not effective in MRIS and TFIS. Table 3 presents farmer perceptions of management effectiveness in the scheme. Across the study irrigation schemes, irrigators were satisfied with the primary committee and perceived the election process to be fair. The management system was functional, meetings were held monthly, and irrigators were involved in decision-making processes and in making rules on the scheme. This indicates transparency in the scheme.

All the study irrigation schemes had constitution drafted by the scheme members with the assistance from extension officers and traditional authorities. The constitution stipulates the rules regarding land and water allocation, operation of the scheme, penalties for non-compliance, norms for farmer participation and conflict resolution mechanism. During focus group discussions and key informant interviews, irrigators confirmed the existence of the constitution and perceived the constitution to be effective in the management of water resources. However, the survey results revealed the opposite in MRIS and TFIS.

Table 3. Farmer perceptions of management effectiveness

	Irrigation scheme	SD	D	N	A	SA	χ^2
Satisfied with the current executive committee (%)	MRIS	3.3	8.3	11.7	37.5	39.2	NS
	TFIS	1.7	5.8	10.8	45.0	36.7	
	NIS	5.9	2.9	2.9	55.9	32.4	
The election process of the executive committee is fair (%)	MRIS	1.7	5.8	12.5	39.2	40.8	NS
	TFIS	2.5	1.7	10.8	41.7	43.3	
	NIS	0.0	0.0	2.9	52.9	44.1	
Satisfied with the involvement of farmers in making rules (%)	MRIS	3.3	4.2	16.7	53.3	22.5	***
	TFIS	0.0	3.3	16.7	41.7	38.3	
	NIS	0.0	0.0	11.8	82.4	5.9	
Existence of appropriate rules in irrigation water management (%)	MRIS	1.7	2.5	28.3	56.7	10.8	**
	TFIS	0.8	3.3	31.7	43.3	20.8	
	NIS	0.0	3.0	3.0	66.7	27.3	
Existence of constitution to assist irrigation water management (%)	MRIS	2.5	5.8	52.5	20.0	19.2	***
	TFIS	0.0	13.3	52.5	14.2	20.0	
	NIS	3.0	6.1	0.0	69.7	21.2	
The constitution is effective in management of water resources (%)	MRIS	1.7	6.7	44.2	36.7	10.8	***
	TFIS	0.0	15.0	32.5	36.7	15.8	
	NIS	3.0	3.0	12.1	66.7	15.2	
Satisfied with the level of contribution of the traditional council in rule enforcement (%)	MRIS	1.7	6.7	22.5	46.7	22.5	***
	TFIS	5.0	9.2	41.7	29.2	15.0	
	NIS	5.9	20.6	29.4	35.3	8.8	
Fairness in water allocation rules (%)	MRIS	6.7	11.7	21.7	45.0	15.0	**
	TFIS	2.5	1.7	10.0	60.8	25.0	
	NIS	6.1	15.2	3.0	60.6	15.2	
Fairness of the scheme rules (%)	MRIS	5.0	11.7	17.5	52.5	13.3	*
	TFIS	2.5	2.5	10.8	65.0	19.2	
	NIS	0.0	12.1	12.1	60.6	15.2	
Compliance to the rules of the scheme (%)	MRIS	0.8	0.0	10.8	31.7	56.7	NS
	TFIS	0.0	3.3	15.0	25.8	55.8	
	NIS	0.0	0.0	0.0	36.4	63.6	

*Note: *** = p<0.01; ** = p<0.05; * = p<0.10 and NS = not statistically significant*

SD= Strongly disagree; D= Disagree; N=Neutral; A= Agree and SA= Strongly agree

Source: Survey data (2018)

A high percentage of irrigators (52.5%) from MRIS and TFIS neither affirmed nor denied, implying that the majority of irrigators had no knowledge about the scheme constitution and its importance. This could be attributed to ordinary scheme members not attending scheme meetings. Only the majority of irrigators from NIS who affirmed the existence of the constitution.

The scheme rules including water allocation rules stipulated in the constitution were perceived as fair. Irrigators also showed satisfactory compliance with the scheme rules (more than 80% compliance), especially in NIS where everyone complied.

However, there was no statistically significant difference in the variation in farmer perceptions of the election process, the effectiveness of the scheme committee and compliance of irrigators with the scheme rules across the study irrigation schemes, implying that election process was similar across. The statistically significant variation in the existence of scheme rules and constitution, their effectiveness and fairness imply scheme rules, water allocation differs across the schemes due to different irrigation technologies employed.

Unfortunately, most irrigators were not willing to participate in the scheme committee. In the feedback workshops irrigators showed no interest for participating in scheme leadership for the following reasons: it is not easy to lead people since they have different personalities; being a member of the scheme committee is time-consuming and end up neglecting your crops, sometimes do not even get water on your irrigation day; self-doubt not educated and not used to meetings, and it is costly, you use your own money for transport and phone calls, and time away from plots.

3.3.3 Land allocation

The study irrigation schemes are in rural areas where the chief is the custodian of land and responsible for land allocation. Across the schemes, irrigators did not have title deeds, only Permission to Occupy (PTO). In NIS irrigators acquire land from Ingonyama Trust. In MRIS and TFIS irrigators were satisfied with land allocation and did not want the terms of land allocation to change, while irrigators in NIS revealed that they were not happy with terms of land allocation because customary laws might change in the future (Figure 2). Results indicated insignificant land rental across the schemes indicating non-existence of land market.

Farmer satisfaction and the perceptions with land allocation showed statistically significant differences across the schemes. This implies that although all the study irrigation schemes are under tribal authorities, terms of land allocation differ across. For example, in MRIS, both men

and women can obtain land from the chief. While women in TFIS were discriminated as only men are given land by the chief. Women can only inherit land in the death of a husband and only sons can inherit land in the death of both parents.

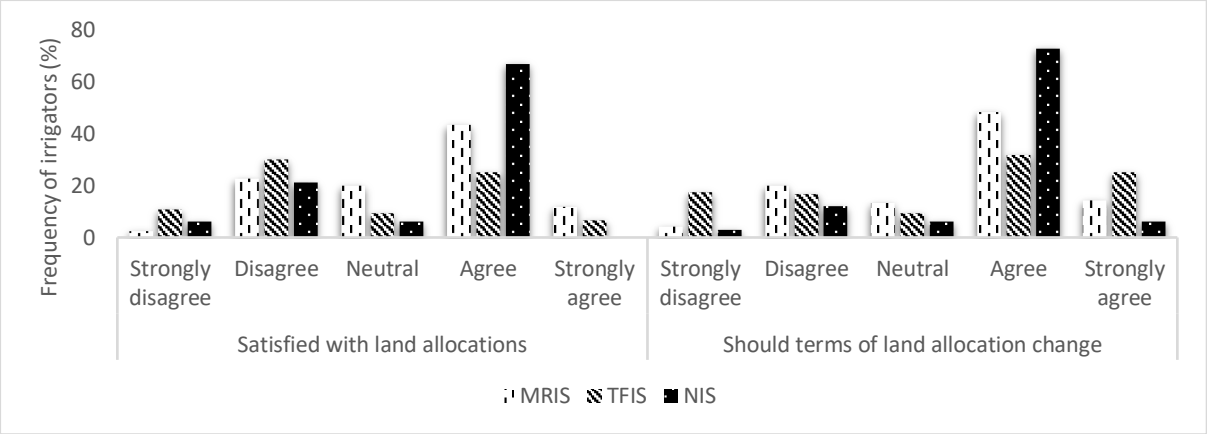

Figure 2. Farmer perception of land allocation

Source: Survey data (2018)

Land ownership and the way irrigable is acquired in this study is consistent with what has been reported in the literature. The majority of women acquired land through inheritance, traditional allocation and/ or given by relatives. However, most of the plots held were not in their names (Table 4).

Table 4. Land ownership across gender in the scheme

Land ownership	Gender		
	Female	Male	χ^2
Traditional allocation (%)	44.2	49.1	
Rented (%)	0.9	5.5	
State supplied (%)	2.3	1.8	*
Inherited (%)	32.3	29.1	
Owned (%)	5.1	9.1	
Given by relative (%)	15.2	5.5	
In your name (%)	45.6	74.1	***

*Note: *** = p<0.01; ** = p<0.05 and * = p<0.10*

Source: Survey data (2018)

Likewise, young people acquired land through inheritance and did not have ownership of the plots they were cultivated as the plots were not registered in their names (Table 5). This also came up in the feedback workshop in TFIS where irrigators revealed that women were not allowed to acquire land on their own and daughters were not allowed to inherit land from their parents, only sons were allowed. The unequal treatment between men and women can be

attributed to customary laws and cultural norms since land is administered by traditional authorities.

Table 5. Land ownership across age groups in the scheme

	Age Group (Years)				
Land ownership	20-35	36-56	57-69	70-88	χ^2
Traditional allocation	25.8	37.4	58.2	50.0	
Rented	6.5	1.9	1.1	0.0	
State supplied	0.0	0.9	2.2	7.1	
Inherited	51.6	32.7	25.3	28.6	***
Owned	0.0	9.3	2.2	9.5	
Given by relative	16.1	17.8	11.0	4.8	
In your name	20.7	24.3	74.7	90.2	***

*Note: *** = p<0.01; ** = p<0.05 and * = p<0.10*

Source: Survey data (2018)

Land distribution across gender and age group had statistically significant variations across indicating that men and women are not equally treated and that the young and elderly do not have equal accessibility to land resources in rural areas.

3.3.4 Water distribution and management

The study irrigation schemes had different water distribution mechanisms, and this can be attributed to the irrigation techniques employed. NIS uses modern irrigation technology (sprinklers) which enables all irrigators to irrigate simultaneously. Hence, irrigation schedule was not used, and irrigators could irrigate daily. On the contrary, MRIS and TFIS had rotational irrigation schedule and irrigators were only supposed to access irrigation water once a week as per irrigation schedule. The stipulated irrigation roster in MRIS specified that Monday was for Blocks 1-4; Tuesday for 5-8, Wednesday for Blocks 9-13 while Thursday and Friday were for Blocks 14-15. No one was permitted to irrigate on Saturday due to traditional restrictions. Sunday as well was not assigned for irrigation. Across the schemes, irrigation water usage at plot level was not monitored, irrigators used water according to their own perceived needs.

According to Annandale *et al.* (2011), irrigation scheduling plays a significant role in minimizing water wastage and stabilizing agricultural production during the periods of water stresses. Many SISs in developing countries such as Haiti, Zimbabwe, Ethiopia, South Africa etc, use irrigation schedule for water distribution (Letsoalo & Van Averbeke, 2005; Boyer, 2007; Deribe, 2008). Figure 3 shows that irrigators across the study irrigation schemes were satisfied with the irrigation schedule and perceive water distribution to be fair. However, there was an inherent water conflict that occurs between irrigators within and between blocks.

Among the study irrigation schemes, NIS irrigators were most satisfied with the irrigation schedule and perceived water distribution as fair. While MRIS had outstanding water conflicts with and between blocks. Downstream irrigators complained that those upstream obstruct the flow in canals to irrigate their own crops. A similar problem was experienced in other irrigation schemes in South Africa, Zimbabwe, Kenya, etc (Samakande *et al*., 2002; Letsoalo & Van Averbeke, 2005; Simitu & Odira, 2007). Irrigators revealed that before decentralization government hired water-bailiffs who assisted with the control of water withdrawals from the canal. MRIS irrigators still believe that hiring water-bailiffs could be a solution to the low water supply at the scheme tail-end.

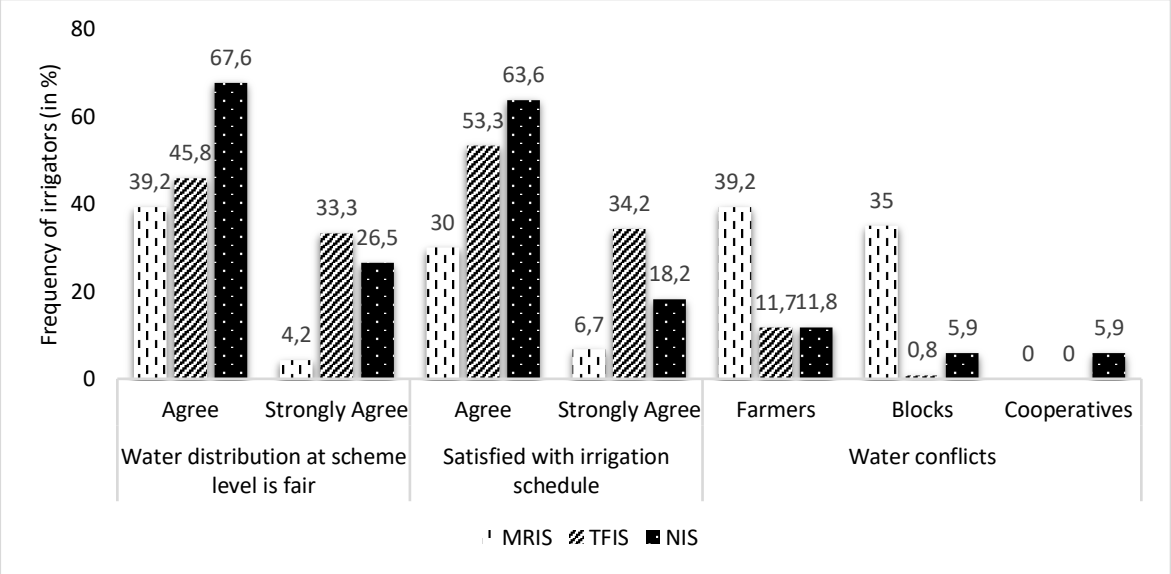

Figure 3. Water distribution system and conflicts across the study irrigation schemes

Source: Survey data (2018)

Irrigators across the schemes were not legally recognized as water users since they were not registered and did not have water permit nor water rights, hence they were not paying for water resources. NIS and TFIS irrigators were only paying for electricity and diesel consumed by the water pump, respectively. Most irrigators in MRIS and TFIS were not willing to pay for water because they regarded it as a natural resource rather than as an economic good.

3.3.5 Enforcement of rules

Across irrigation schemes, noncompliance and unlawful behaviour were reported to the scheme committee where they were punished accordingly, usually by imposing a monetary fine. Traditional authorities also played an important role in the disciplinary of irrigators and resolving water conflicts. Involvement of the Chief made the fine to be heavier than that imposed by the scheme committee. However, it is often difficult to impose penalties due to

humanity. For example, in TFIS, irrigators revealed that there were no penalties imposed for non-compliance. Irrigators in MRIS indicated that offenders were punished and there were some cases where noncompliance was reported to the Chief, and offenders had to pay a fine amounting to R300. Figure 4 showed that irrigators across the scheme believed that penalties impose for noncompliance were fair and the rules were not hard to enforce. This is also reflected by the high percentage of farmer perception on compliance with scheme rules (Table 3).

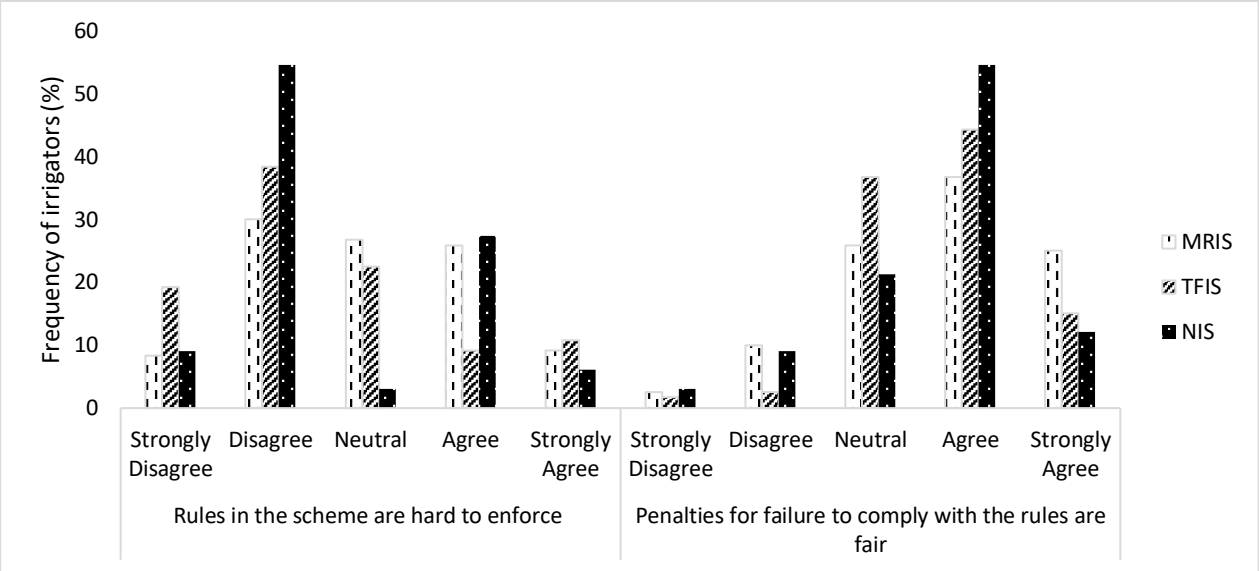

Figure 4. Rule enforcement and fairness of penalties

Source: Survey Data (2018)

Unlawful behaviour was often not reported in MRIS and TFIS. Farmers threaten each other with death which instilled fear among weak farmers. A similar situation was also reported by Samakande *et al.* (2002) where farmers threaten each other with witchcraft. MRIS and TFIS had the problem of unauthorized water withdrawals by community members for domestic purposes including laundry, brick making, livestock drinking, etc. which contributed to a decrease in water supply.

3.3.6 Conflict resolution mechanism

Water theft and non-compliance with irrigation schedules are often the main cause of conflicts. Table 3 shows that irrigators across the study irrigation schemes were satisfied with the conflict resolution mechanism. Conflicts were managed informally and out of court through the following mechanism:

- One-to-one level: Irrigators involved in the dispute speak out and resolve the conflict

- Block level: In the failure of the one-on-one dispute resolution, the chairperson of the block gives both parties a chance to talk about the source of a dispute then give a more trusted judgement

- Scheme level: This is usually employed when the dispute is between blocks and if the above mechanisms fail. The scheme committee (secondary committee) is involved to give their best judgment to the cause of the dispute.

- Traditional authorities and the community court: This is a more formal dispute resolution mechanism responsible for managing almost all types of disputes in the community. The Chief, Induna and the community gather to hear out the source of the conflict, only the chief gives out the final judgement and the fine if necessary. However, there are very rare scheme disputes that escalate to this point.

Letsoalo & Van Averbeke (2005); Sokile *et al.* (2005) and Deribe (2008) in their studies also reported that conflicts were resolved informally, and irrigators preferred informal conflict resolution mechanisms and penalty enforcement over the formal mechanisms.

3.3.7 Irrigation infrastructure maintenance

The maintenance of irrigation infrastructure is crucial for the sustainability of an irrigation scheme and for improved agricultural output (Samakande *et al.*, 2002). Following decentralization, irrigation infrastructure maintenance became the responsibility of irrigators. All irrigators participated either financially or physically in irrigation infrastructure maintenance. Since the irrigation infrastructure and irrigation technique used differ across irrigation schemes, farmer contribution in irrigation infrastructure maintenance also differ. MRIS used the canal and short furrow irrigation method, TFIS used both canal and water pumps, and a short furrow irrigation method, while NIS used water pump and sprinkler irrigation technique. Irrigation infrastructure maintenance in NIS is done by contractors, while irrigators contribute finances to pay them. While in MRIS and TFIS, irrigation infrastructure maintenance (canal cleaning) was physically done by irrigators, but the Department of Land Reform and Rural Development (DLRRD) rehabilitated the scheme. The farmers who absconded canal cleaning duties pay money or send someone to work on their behalf. During the survey, irrigators indicated high participation in irrigation maintenance especially in NIS (Figure 5), and the variation in farmer participation was statistically significant ($p=0.0001$) indicates the difference in irrigation infrastructure, the scale of production and understanding of IMT across the schemes. In NIS can only be maintained by hiring contractors while in the

other irrigation schemes irrigators can provide labour to fix the infrastructure themselves. Although irrigation management is now the responsibility of irrigators, they still plead for assistance with the maintenance of irrigation infrastructure as it expensive for them to maintain.

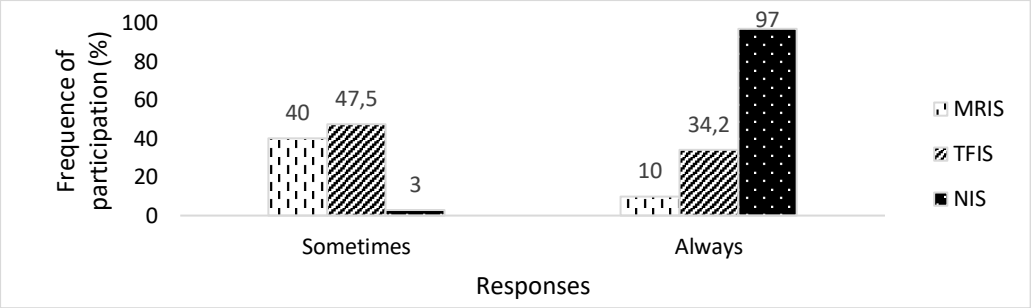

Figure 5. The contribution of finances towards irrigation maintenance across irrigation schemes

Source: Survey data (2018)

3.3.8 External stakeholder participation

Although irrigations schemes are now managed by water users, government and private sector still have a role to play to ensure the sustainability of SIS. Irrigators in the study irrigation schemes work together with different external stakeholders depending on which ones are available in the area. The Department of Agriculture and Rural Development (DARD) and LIMA provide extension services and production inputs (usually in the form of loan for LIMA) in MRIS and TFIS. DARD, LIMA, and TechnoServe provide various services to NIS irrigators. In MRIS and TFIS, extension officers are the only contact farmers have with the government department of agriculture.

3.4 Conclusions and Recommendations

Studies that have been conducted in developing countries to assess the institutional arrangements on water management indicated that SISs largely use informal rules in managing the scheme, and water resources. In most irrigation schemes informal water institutions and farmer participation in irrigation management have shown positive results and have contributed to the sustainability of SISs, although the claims of unsatisfactory performance remain.

The results obtained in this study indicated that MRIS, TFIS and NIS had functional institutions governing the use and management of water resources. The scheme committee facilitated the scheme management responsibilities such as water allocation, rule enforcement, conflict resolution, organising irrigation infrastructure maintenance. Traditional authorities also played

an important role in scheme, especially in conflict resolution. Irrigators participated in irrigation management and in decision-making processes in the scheme, which could have contributed to the sustainability of the study irrigation schemes.

The prevailing institutional arrangements in the study irrigation schemes seemed to be effective as the schemes, particularly MRIS and TFIS have been operational for a long time. Although NIS is a newly established irrigation scheme with modern irrigation technology, institutional arrangements in the scheme work effectively to sustain the operation of the scheme. Irrigators do everything by themselves without government assistance. This indicates that irrigators understand that they are in the IMT era and this should be encouraged also in MRIS and TFIS. Irrigators should be encouraged to take all the scheme matters to their own hands.

3.5 Summary

This chapter addressed the first objective of the study which was to describe institutional arrangements for water management in Mooi River, Tugela Ferry and Ndumo irrigation scheme using the descriptive statistical technique. It started off by generalizing on the institutional arrangements in SISs. Results revealed that all the study irrigation schemes had functional water institutions that were effective in irrigation and scheme management. The schemes had Block committees responsible for water allocation, formulating and enforcing scheme rules, resolving conflicts with an aid of traditional authorities, as well as to arrange irrigation infrastructure maintenance. Plots within the scheme were allocated by the chief. The next chapter will address the second objective of the study.

CHAPTER FOUR: DETERMINANTS OF FARMER AWARENESS OF WATER GOVERNANCE DIMENSIONS ACROSS INTERGENERATIONAL AND GENDER DIMENSIONS IN SMALLHOLDER IRRIGATION SCHEMES IN KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Abstract

Water is a vital resource for irrigated agricultural production and its availability and accessibility is critical for alleviating poverty and achieving food security in rural households. However, the smallholder irrigated agriculture in South Africa faces limited water supply emanating from scheme governance problems, with weak institutional arrangements that fail to equitably and effectively govern water resources. Poor institutional arrangements of water use and management in smallholder irrigation schemes in South Africa make most schemes dysfunctional. Although recognised globally as progressive water policy, the South African National Water Act of 1998 is unknown in SISs. This chapter argues that both formal and informal water institutions are essential for efficient and sustainable distribution and use of irrigation water among users.

This study sought to assess farmer awareness of water governance across intergenerational and gender dimensions in Mooi River, Tugela Ferry and Ndumo irrigation schemes. The study employed Principal Component Analysis to generate water institution indices, that is, formal institution, the existence and effectiveness of scheme constitution, scheme committee and enforcement of informal rules in the scheme. The Ordinary Least Square regression technique was then used to identify factors determining farmer awareness of formal and informal water institutions in the three irrigation schemes.

The findings suggest that formal water institutions are unknown and factors such as household characteristics, irrigation scheme, stakeholder participation and involvement in scheme decision-making processes significantly influence awareness of governance. Therefore, there is a need to raise farmer awareness of formal water institutions and to strengthen the informal institutions which are functional, recognised and in line with irrigation management transfer.

4.1 Introduction

Water is a vital resource for irrigated agricultural production, its availability and accessibility are critical for alleviating poverty and achieving food security in rural households (Denby,

2013). However, the smallholder irrigated agriculture in South Africa faces limited water supply emanating from scheme governance problems, with weak institutional arrangements that fail to equitably and effectively govern water resources (Denby, 2013). In many African countries, water has been traditionally acquired from open water sources such as natural springs, hand dug wells or surface water, hence institutions regarding management were unknown (Schnegg & Bollig, 2016). This is because in the past water rights were not important and inferior to land rights. The rapidly growing water demand associated with water scarcity leads to the tragedy of the commons, whereby the resource deteriorates due to lack of control and incentives to protect it (Meinzen-Dick & Nkoya, 2005).

According to Tshuma & Monde (2012) and Muchara (2014), poor institutional arrangements and management in SISs in South Africa make most of them dysfunctional. Therefore, water rights, water governance and institutional arrangements to control and regulate the use of water become extremely important. However, the nature of water and its properties in rural areas make the definition of water rights difficult and costly since water rights are inherently linked to land rights such that ownership of an irrigation plot automatically gives the right to irrigation water access. Meinzen-Dick & Nkoya (2005) argued that the effectiveness of water rights is conditional on the availability of strong institutional arrangements and sound governance.

South Africa has transformed its water laws to address past racial imbalances in accessing water created by the apartheid government. In 1998, South Africa enacted the NWA with an intention to "decentralise and integrate water management, create new local and regional institutions with equal representation, register and licence water use and finally to facilitate the emergence of a water rights market" (Denby, 2013: 2). In 2006, the WAR policy was implemented to reallocate water from the advantaged to economically disadvantaged individuals. However, the implementation of NWA and WAR has been slow, and their expected outcomes have not been realised. For example, compulsory licensing which is one of the mechanisms of the WAR programme has not been widely implemented (DWA, 2013). Likewise, although the NWA is recognised globally as progressive water policy, it is unknown in SISs (Denby, 2013). Meinzen-Dick & Nkonya (2005) argued that if the range and complexity of institutions governing the use of water resources are not understood, any efforts to improve water allocations will be ineffective and not yield the desired outcomes.

Irrigators in SISs define their own rules and regulations regarding water use. Consequently, customary laws tend to be strong and powerful than formal laws. Moreover, statutory laws are

unknown at scheme level due to insufficient communication between government and irrigators (Meinzen-Dick & Nkoya, 2005). Therefore, the study sought to identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in Mooi River, Tugela Ferry and Ndumo irrigation schemes, South Africa.

4.2 Water Institutions for Irrigation Schemes in South Africa

The theoretical framework for this study explains water governance structure in SISs, farmer awareness of water governance and farmer perceptions about the effectiveness of governance in irrigation water allocation and management. Figure 6 illustrates the framework of water governance structure in SISs. The study argues that both formal and informal water institutions are essential for efficient and sustainable distribution of irrigation water among users. According to Gallaher & Heikkila (2014), water governance is about collective decisions and choices relating to the use and management of water resources that emerges through institutions. It encompasses the mechanisms of setting rules and institutions with which water resources are managed. Moreover, water governance decides on who gets how much water, when and how (Hill, 2013). This framework uses water institutions to represent water governance.

Water institutions consist of both formal and informal institutions shaping the actions of irrigators towards water resources and specifying the permissible and restricted behaviour (Gallaher & Heikkilla, 2014). According to Sokile *et al*. (2005: 1), formal institutions are "the written ordinances created by the legislative council before the independence and contemporary legislation in one hand", while, informal water institutions are defined as "the set of local, community-based practices that are normally determined by local customs, traditions and culture of water use". The key pillars of water institutions include water laws, water policies and water organizations (Boyer, 2007).

Gallaher & Heikkilla (2014) argued that sustainable use and management of water resources can be achieved through institutions and organizations. Efficient and sustainable use of irrigation water and irrigation schemes is influenced by both formal and informal institutions and the participation of irrigation water users. According to Sokile *et al.* (2005) and Deribe (2008), formal and informal water institutions are interlinked, and their effectiveness depends on the constitutions, water management organizations at national, basin and scheme level as well as the customary behavioural changes of the society

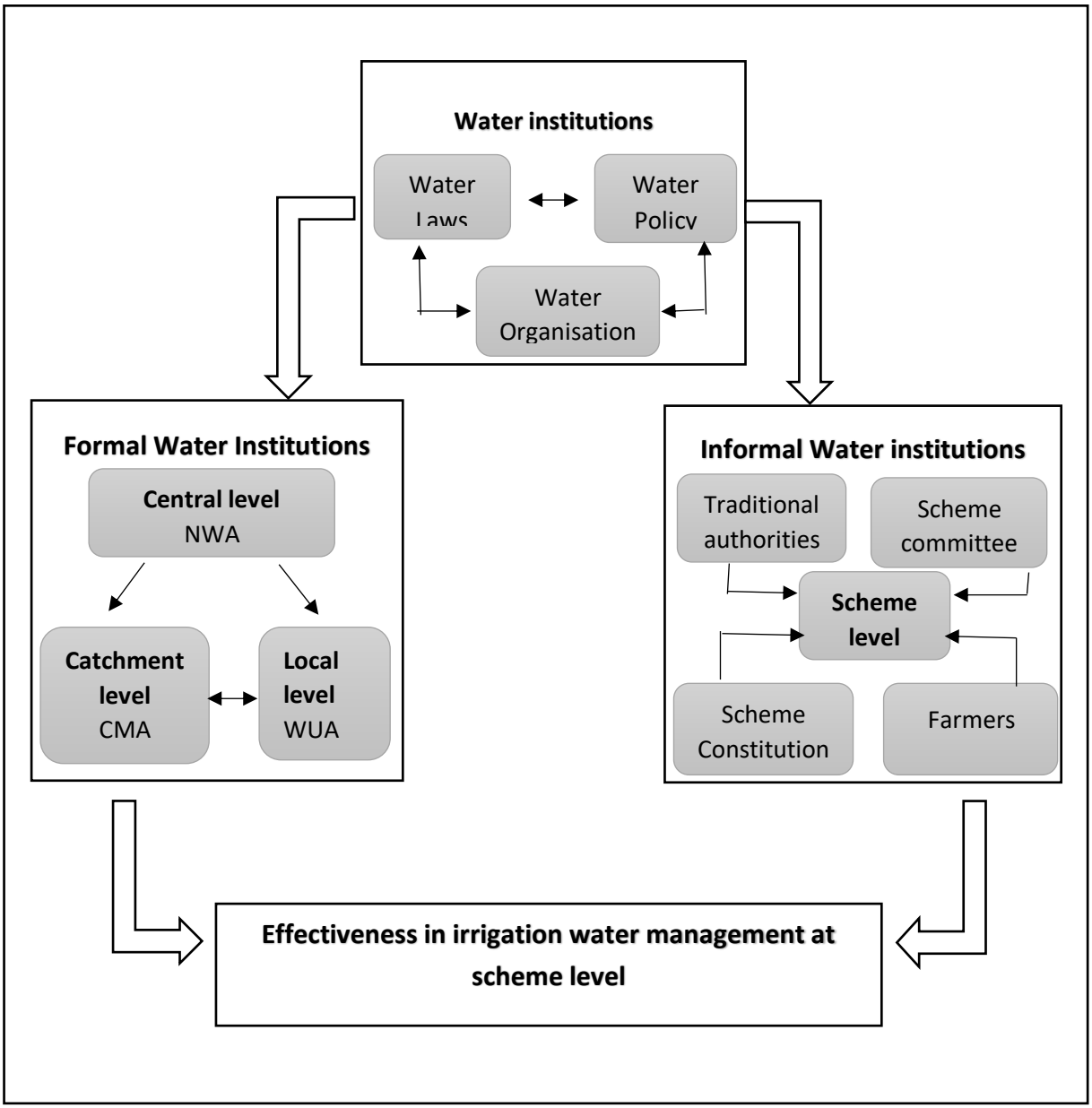

Figure 6. The framework of water governance structure in smallholder irrigations schemes

Source: Authors compilation (2018)

4.2.1 Formal water institutions

a) National level

At the macro level, the government is the custodian of water resources and water management is solely guided by formal water institutions (water policies, water laws and water management organizations) (Sokile *et al.*, 2015). The Minister of Water Affairs and Forestry (DWAF) implemented the NWA to ensure that South Africa's water resources were protected, used,

developed, conserved, managed and controlled (RSA, 1998). The Act proposes to redress past racial imbalances in water access by the apartheid government which gave privileges to the white minority and to ensure equitable access to water as well as to improve efficiency and sustainability in water use. To achieve its objectives, the Act established two water resource management organizations, the CMA and WUA, which allows water user participation in the decision-making process. Vermillion (1999) cited in Boyer (2007) argued that irrigation scheme will not achieve satisfactory performance levels without basic institutional reforms such as decentralization of irrigation management to irrigators and their organizations.

b) Catchment level

The CMAs are statutory bodies established to manage water resources at the catchment level. The key functions of the CMA included developing and implementing the catchment management agency strategy underpinning the principles of the NWA in a defined management area and promotes community participation in water resource management (Karodia & Weston, 2001). CMAs have a link with many other water management institutions such as WUAs, DWAF, etc. WUAs assist in implementing the CMA strategy at a local level. The implementation of CMAs in South Africa has not been successful. Bourblanc & Blanchon (2014) reported that only two CMAs had been established. Poor administration, mismanagement, lack of training of newly appointed public servants and coordination problems are among the reasons contributing to the failure of CMAs (Bourblanc & Blanchon, 2014).

c) Local level

Although the NWA permits the abstraction of water without licences or permits, irrigators were required to form WUAs, so they can apply for water license which will determine the amount of water each user is entitled to withdraw from normal situations as well as their collective rights to the water resource and their obligation (RSA, 1998; Perret, 2002). However, the adoption of WUAs in South Africa is very poor because its role has never been conceptualized nor fully defined to smallholder irrigators from the onset. Meinzen-Dick (1997) cited in Saruchera (2008) argued that the success of WUAs can only be realised if there are sound legal frameworks, incentives for irrigators to participate, sufficient knowledge about WUAs, significant understanding of water issues and effective communication skills. In other developing countries where WUAs have been established, smallholder farmers claim that WUAs do not provide the kind of benefits they are expecting such as lobbying government

support to practice meaningful agriculture and that WUAs are ineffective and not beneficial to the previously disadvantaged.

4.2.2 Informal water institutions

Although both formal and informal water institutions are equally important in water resource management, informal institutional arrangements tend to be more valuable, influential and powerful at scheme level due to low dissemination of the state laws. Moreover, irrigators have an incentive to follow and enforce rules they formulated themselves than those handed down from an outside authority (Tang & Ostrom 1993; Sokile *et al*., 2005; Deribe 2008). There are often contradictions between formal and informal water institutions, and most contradictions tend to appear from those formal institutions that encourage gender equity (Bandaragoda & Firdousi, 1992; Huggins, 2002). Meinzen-Dick & Nkoya (2005) argued that customary laws lack the equity principle which greatly affects the distribution of resources among users, leaving women and the poor vulnerable. While, state laws always seek to ensure equality in resource allocation, at least on paper.

4.2.3 Farmer awareness and perceptions about water institutions

With little evidence documented, smallholder irrigators seem to be unaware of formal water institutions. Mehta *et al*. (2014) found that smallholder farmers in the Inkomati catchment management area (South Africa) lack knowledge of the NWA, formal water policy and other formal channels for accessing water reflecting poor communication between national government, local government and water users at the farm level. In Haiti, irrigators perceived informal water institutions together with strong farmer participation more convenient and perform better in providing related services to farmers as compared to formal institutional settings. In addition, operational rules, rule enforcement, sharing responsibilities among members, matching cost-recovery to relevant provided services have been more efficient and effective in farmer-managed irrigation systems compared to agency-managed irrigation system (Boyer, 2007: 14). Likewise, in the studies by Sokile *et al*. (2005) and Deribe (2008) smallholder irrigators operated with informal institutions and preferred informal conflict resolution mechanisms and penalty enforcement over the formal mechanisms. The high preference for informal institution indicates that formal institutions are unknown or ineffective, or that informal water institutions are very effective in water and scheme management.

4.3 Methodology

This section provides the research methods used in this study, briefly explaining the study area, sampling and data collection techniques, data analysis method used as well as describing the independent and dependent variables used in the analysis.

4.3.1 Conceptual framework

The conceptual framework for this study has been discussed in detail in chapter 3, section 3.2.1.

4.3.2 Study area

The survey was undertaken in Mooi River, Tugela Ferry Irrigation Schemes located in Msinga Local Municipality in Umzinyathi District and Ndumo Irrigation Scheme located in Jozini Local Municipality in Umkhanyakude District. Irrigation schemes from different districts were included to capture the variation in farmer awareness of water governance since both formal and informal water institutions influence water-use efficiency and sustainability of the irrigation scheme. Table 6 summarises the characteristics of the study irrigation schemes.

Table 6. Characteristics of the study irrigation schemes

Description	Irrigation scheme		
	MRIS	TFIS	NIS
District	uMzinyathi	uMzinyathi	uMkhanyakude
Local Municipality	Msinga	Msinga	Jozini
Average annual rainfall	600-700 mm per annum	600-700 mm per annum	600-800 mm per annum
Total irrigated land	~600ha	~800ha	~1500ha
The composition of the scheme	15 blocks, all functional	7 blocks, one block (6) not irrigated	Phase 1 and Phase 2
Water source and diversion method	Mooi River; canal	Tugela River, Canal, diesel and electric water pump	Pongola River, electric water pump
Irrigation method	Canal – furrow irrigation	Canal and piped-furrow irrigation	Sprinkler
Management type	Farmer-managed	Farmer-managed	Farmer-managed
Water distribution method	Irrigation schedule	Irrigation schedule in block 4	None

Source: Msinga Municipality (2011); Muchara *et al*. (2014); Jozini Municipality (2017)

4.3.3 Data collection methods and sampling techniques

Data collection methods and sampling techniques used in the study were discussed in chapter 3, section 3.2.2.

4.3.4 Empirical model

The study employed the Principal Component Analysis (PCA) and the Ordinary Least Squares (OLS) techniques. PCA was used to generate indices indicating formal and informal water institutions in SISs. OLS regression technique was applied to identify factors influencing farmer awareness of formal and informal water institutions. Several researchers including Muchara (2014); Wuttichaikitcharoen & Babel (2014) used this approach.

4.3.4.1 Principal Component Analysis

According to Everitt & Hothorn (2011: 61), PCA is a "multivariate technique with the central aim of reducing the dimensionality of a multivariate data set while accounting for as much of the original variation as possible". It transforms original variables to a new set of variables, the principal components (PCs), that are a linear combination of the original variables, which are ordered so that the first few PCs retain most of the variation present in all original variables (Jolliffe, 1986; Everitt & Hothorn, 2011). Moreover, PCA eliminates the possibility of multicollinearity by replacing the highly correlated variable with few uncorrelated PCs (Jolliffe, 1986). The major indicators on formal and informal water institutions were asked in a Likert scale type questions, with farmers indicating whether they strongly disagreed, disagreed, were neutral, agreed or strongly disagreed. Index values increase from 1 to 5 if the respondent strongly agrees and decreases from 5 to 1 if the respondent strongly disagrees.

4.3.4.2 Ordinary Least Squares Regression Model

The generated indices from the PCA were regressed against explanatory variables known to influence farmer awareness using the OLS technique. The number of regression models to be estimated equals the number of the retained PCs. According to Gujarati & Porter (2009), the OLS regression model can be specified as

$$Y_i = \beta_0 + \beta_i X_i + \mu_i$$

Where Y_i is the water institution index for the ith irrigator; X_i is a vector of explanatory variables; β_0 and β_i are the vector of parameters to be estimated and μ_i is the error term.

4.3.5 Description of dependent and explanatory variables

Dependent Variables

The suitability of data set to be used in PCA was examined using Bartlett's test of sphericity which checks if the observed correlation matrix diverges significantly from the identity matrix (H_0: the variables are orthogonal) and the Keiser-Meyer-Olkin (KMO) which is a measure of sampling adequacy. The Bartlett's tests for formal and informal water institutions were statistically significant (p=0.0001) implying that the variables were not inter-correlated suggesting that the PCA can be performed efficiently on the data set. The KMO for formal and informal institutions were 0.603 and 0.631, respectively. Both these values were at least 0.5 implying that the PCA can precisely be applied to the data set (Kaiser & Rice, 1974).

The PCs were generated using a covariance matrix since the variables included had similar scale measurement, Likert scale (Everitt & Hothorn, 2011). The decision on the number of PCs to retain was based on the Kaiser criterion which suggests that PCs with eigenvalues above one can be retained was applied (Ibid.). Hence, three PCs representing informal and another three PCs representing formal water institutions were retained. Table 7 and 8 present the generated PCs as indicators formal and informal water institutions, respectively.

With reference to Table 7, the first three PCs retained explained for 72.13% of the total variation in the data, cumulatively. The first PC had a higher explanatory power, explaining about 36.35% variation in farmer awareness of formal water institutions. The second and third PC accounted for 18.72% and 17.07%, respectively. The PC vector of PC1 is economically meaningful, as all its coefficients are positive and have larger component loadings. Each variable represents formal institutions governing water in irrigation schemes. Therefore, the positive component loadings indicate that PC1 represents farmer awareness of formal water institutions (FORMAL_INSTI).

The first retained PC in Table 8 explained 29.53% of the total variation in the major indicators of formal water institutions and had similar signs of the estimated component loadings. PC_1 was found to be closely related to farmer perceptions of the effectiveness of the scheme committee in water resource management and conflict management in the scheme. Hence, it was named the availability of the scheme committee (SCHEME_COM).

Table 7. Principal component analysis of the major indicators of formal water institutions at scheme level

Description of variables	Principal Component		
	PC_1	PC_1	PC_1
Awareness of NWA	**0.902**	-0.169	-0.095
Awareness of NWRS	**0.890**	-0.163	-0.101
Knowledge of government aims	**0.596**	-0.057	**0.484**
Availability of water licences	0.118	**0.758**	-0.370
Availability of water rights	0.156	**0.610**	**0.682**
Knowledge of any WUA	**0.427**	0.343	-0.411
Eigenvalue	2.181	1.123	1.024
% of variance explained	36.34%	18.72%	17.07%
Cumulative % variance explained	36.34%	55.06%	72.13%
KMO	0.603		
Bartlett test of sphericity	$\sim\chi^2 = 372.542$ ($p < 0.001$)		

Note: Component loadings greater than |0.40|are highlighted in bold print

Source: Survey data (2018)

The second retained PC accounted for 20.78% of the total variation in the major indicators of informal water institutions. This PC was found to be closely related to farmer perceptions of the effectiveness of the scheme constitution in water resource management in the scheme when scheme rules are hard to enforce. The scheme constitution stipulates the rules regarding land and water allocation, operation of the scheme, penalties for non-compliance, norms for farmer participation and conflict resolution mechanism. PC_2 was therefore named farmer awareness of the existence of the scheme constitution (SCHEME_CONST), the role played by the scheme committee in enforcement rules stipulated in the scheme's constitution.

Irrigation schemes have rules developed for managing water resources, and those rules are stipulated in the constitution. For these rules to work effectively they need to be enforced. The third retained PC explained 18.42% of the total variation in the major indicators of informal water institutions. This PC was found to be closely related to farmer perceptions of difficulties in the enforcement of rules in the scheme. Hence, the PC was named rule enforcement (RULE_ENF).

Table 8. Principal component analysis of the major indicators of informal water institutions at scheme level

Description of variables	Principal Components		
	PC_1 SCHEME_COM	PC_2 SCHEME_CONST	PC_3 RULE_ENF
Presence of appropriate rules in irrigation water management	0.2235	0.1548	-0.3591
The existence of a constitution to assist in water management in the scheme	0.3523	**0.4359**	-0.4068
Difficulties in rule enforcement	0.2495	**0.5335**	**0.7629**
The effectiveness of constitution in water management	0.3367	0.3192	-0.3013
Fair penalties to non-compliance	0.3463	0.0266	0.1057
Satisfaction with conflict management in the scheme	**0.4265**	-0.1985	0.0889
Satisfaction with the scheme committee	**0.4468**	-0.4761	0.1149
Fairness in the election process of the scheme committee	0.3858	-0.3644	0.0228
Eigenvalue	2.173	1.529	1.355
Variance explained	29.53%	20.78%	18.42%
Cumulative % of variance explained	29.53%	50.31%	68.78%
KMO	0.631		
Bartlett test of sphericity	$\sim\chi^2$ = 690.388 p < 0.001		

Note: Component loadings greater than |0.40|are highlighted in bold print

Source: Survey data (2018)

Explanatory variables

Studies that have been done on farmer awareness indicated that household characteristics, membership in farmer organisations, source of information, access to extension services and stakeholder participation are some of the influential factors to farmer awareness to national policies (Muatha, 2014; Okpeke *et al*., 2015; Duhan & Singh, 2017; Duhan & Dhingra, 2018). Therefore, this study predicted that farmer awareness of water institutions is influenced by household demographics, scheme location, stakeholder involvement in the scheme,

participation in scheme leadership and in decision-making processes, membership in farmer organizations and accessible sources of information. However, the effects of factors influencing farmers awareness of water institutions vary across formal and informal water institutions. Due to the scantiness of existing literature on factors influencing farmers awareness of water institutions at scheme level, the relationships between institutional variables and the explanatory variables cannot clearly be depicted. Table 9 provides a description of the variables included in the analysis.

Table 9. The description of variables included in the analysis and their anticipated effects

Variable	Description	Anticipated effect
Explanatory Variables		
AGE	The age of an irrigator (years)	-/+
GENDER	The gender of an irrigator (1 if male; 0 if otherwise)	+
EDUC_LEVEL	The level of education an irrigator has received formal education (1= no formal; 2= primary; 3= secondary; 4= tertiary)	+
SCHEME_LOC	Scheme location (1=Msinga; 0=Jozini)	+/-
ROLE_SCHMLED	The role played in scheme leadership (1=ordinary member; 2= block committee; 3=secondary committee)	+
WATM_TRAIN	Whether an irrigator have received formal water management training (1 = yes; 0 = otherwise)	+/-
WUA_MEMB	Whether an irrigator is a member of WUA (1 = yes; 0 otherwise)	+
GOVT_INV	Involvement of government departments in the scheme management (index)	+/-
TRIBAUTH_INV	Involvement of traditional authorities in the scheme management (index)	-/+
INV_SCHMDEC	Irrigator participation in decision-making processes in the scheme (index)	+
INFO_SOURCE	Source of information (index)	+
Dependent Variable		
FORMAL_INST	Farmer awareness of formal water institutions (index)	
SCHEME_CONST	Farmer awareness of the scheme constitution (index)	
SCHEME_COM	Farmer perception about the effectiveness of the scheme committee (index)	
RULE_ENF	Farmer perception about rule enforcement in the scheme (index)	

Source: Author's compilation (2018)

Age: In general, age is one of the factors influencing the level of awareness. According to Duhan & Singh (2017), younger farmers read more from different information sources and are not as reluctant as elder farmers to changes in agricultural/ water policies, hence are more aware compared to elder farmers. They attributed this discrepancy to a different level of education obtained by the two groups. Therefore, in this study, elder irrigators are anticipated to be least aware of formal water institutions and more likely to be aware of informal water institutions.

Gender: In SISs and the African culture women tend to be treated inferior although they make the largest proportion of smallholder farmers. Women are usually denied access to attend meetings, workshop or training (Mudege *et al.,* 2017). Sometimes they are held by household activities they perform. According to Muatha (2014), male irrigators have a higher likelihood to be exposed to the water institutions. Therefore, holding other factors constant, male irrigators are anticipated to be more aware of water institutions than female irrigators.

Level of education: According to Duhan & Dhingra (2018), literacy level and educational qualification influence the level of understanding and awareness. Less educated are assumed to be less aware of water institutions. However, this not always the case. SISs are dominated by elder farmers with no formal education but tend to be more aware of the scheme governance. A positive association between education and farmer awareness of formal institutions is expected, ceteris paribus.

Scheme location: The location of an irrigation scheme (municipality) can influence farmer awareness of water institutions through the extent of external stakeholder involvement in water resource management. Since the study irrigation schemes are in different local municipalities held under the authorities, either a positive or negative influence on farmer awareness of water institutions can be expected.

The role played in scheme leadership: Irrigators who participate in scheme decision-making processes are more likely to be informed about formal institutions and community affairs. According to Mowo *et al.* (2013), local leaders are relatively better educated and are the ones who draw local institutions in their leadership roles. This is because block committee and secondary committee members are scheme leaders, everything that has to do with farmers in SISs goes through the scheme committee, and if there are training or workshops to be provided to farmers, scheme committee members are always expected to attend.

Training: Water management training is critical for improving water-use efficiency and sustainable use of irrigation water in SISs (Namara *et al.*, 2010). Irrigators who have received

water management training are more likely to be aware of formal water institutions, ceteris paribus. Water management training provided by the irrigation committee is likely to disseminate information on the intentions of informal water institutions. Therefore, water management training (WATM_TRAIN) is anticipated to be positively related to farmer awareness of formal and negatively related to informal water institutions, ceteris paribus.

Farmer organizations: Farmer organizations serve as a convenient platform for farmers to disseminate agriculture- and water-related information. WUA is a formal farmer organization established as a strategy for bringing governance in the scheme and for disseminating information about formal water institutions (Manzungu, 2000; Sokile *et al*., 2005). It is therefore anticipated that membership in WUA (WUA_MEMB) is expected to positively increase farmer awareness of both formal and informal water institution, ceteris paribus.

Stakeholder participation: Water resource management in SA is through water legislation (NWA) focusing on ensuring equitable and sustainable allocation of water resources through authorization (licensing and registration) to avoid and control the risks of unsustainable water management (Namara *et al.,* 2010). The involvement of government departments (GOVT_INV) in irrigation schemes will inform irrigators about the formal NWA, its aims and strategies. While the involvement of tribal authorities (TRIBAUTH_INV) is anticipated to increase farmer awareness of informal water institutions as they also play an important role in rule enforcement. Traditional authorities, particularly chiefs, have the power to influence rural farmers (Sokile *et al.*, 2005; Deribe, 2008). Farmer involvement in decision-making processes in the scheme (INV_SCHMDEC) relating water management activities is anticipated to enhance farmer awareness of water institutions, ceteris paribus. In addition, Muatha (2014) asserted that farmer engagement in scheme decision-making processes also plays an important role in maintaining harmony among irrigators.

Source of information: Access to information plays a significant role in agricultural development (Mudege *et al.,* 2017). The most important and easily accessible information sources in the study irrigation schemes include extension officers, media, irrigation committee and fellow farmers. Among these information sources, extension officers and the media play an important role in providing information on national policies (Muatha, 2014). Holding other factors constant, the source of information (INFO_SOURCE) is expected to positively increase farmer awareness of both formal and informal water institutions.

4.4 Results and Discussion

This section presents the results obtained from the survey. It starts off by providing a brief description of household characteristics of the study, institutional arrangements in the scheme, sources of information and information distributing networks as well as an overview of econometric results obtained.

4.4.1 Descriptive statistics

a) Household characteristics

The results obtained from the household survey conducted from the study irrigation schemes indicated that MRIS and TFIS are dominated by women, elderly farmers with an average age of 57 and 55 years, respectively who had not acquired formal education (Table 10).

Table 10. Household characteristics across the study irrigation schemes

Variable	Description	Irrigation scheme			χ^2
		MRIS	TFIS	NIS	
Age group (%)	20 – 35 years	10.1	7.5	32.4	***
	36 – 56 years	37.0	42.5	38.2	
	57 – 69 years	34.5	35.0	23.5	
	70 – 88 years	18.5	15.0	5.9	
Gender (%)	Male	15.8	12.5	67.6	***
	Female	84.2	87.5	32.4	
Level of Education (%)	No formal	64.7	59.2	23.5	***
	Primary	19.3	28.3	23.5	
	Secondary	13.4	11.7	32.4	
	Tertiary	2.5	0.8	20.6	

*Note: *** = p<0.01; ** = p<0.05; * = p<0.10; NS= not statistically significant*

Source: Survey data (2018)

The dominance of women in MRIS and TFIS can be attributed the fact that irrigated farming is regarded as a female activity in Msinga, while male concentrated on cattle rearing and non-farm activities (Muchara, 2014; Sinyolo *et al*., 2014). On the contrary, Ndumo irrigation scheme is dominated by young irrigators with an average age of 46 years and who are better educated with a considerable proportion of irrigators who have reached high school and tertiary level of education (Table 10). Unlike in other SISs, Ndumo irrigators are predominantly male.

b) Farmer awareness of water institutions across irrigation schemes

The results presented in Table 11 indicate that most irrigators were not aware of formal water institutions (WUAs, NWA and NWRS). Hence, the WUAs were non-existent. On average,

very few irrigators indicated to have received water management training in these schemes. NIS irrigators are most aware and have received more water management training than the other two irrigation schemes.

Table 11. Farmer awareness of water institutions across irrigation schemes

Water institution	Awareness	Irrigation scheme			χ^2
		MRIS	TFIS	NIS	
Awareness of NWA (%)	Agree	14.2	1.7	29.4	
	Strongly Agree	2.5	0.0	17.6	***
Awareness of NWRS (%)	Agree	10.0	0.8	14.7	
	Strongly Agree	1.7	0.0	14.7	***
Knowledge of WUAs (%)	Yes	6.7	0.8	6.7	*
Member of WUA (%)	Yes	0.0	0.0	3.1	**
Water management training (%)	Yes	29.2	18.3	44.1	***

*Note: *** = p<0.01; ** = p<0.05; * = p<0.10*

Source: Survey data (2018)

The statistically significant differences in farmer awareness of formal water institutions across irrigation schemes could be attributed to the variation in the accessibility of relevant information. Among the available information sources, extension officers, media, fellow farmers, community meetings, irrigation committee, traditional leaders and cooperatives readily served as information sources for irrigators.

4.4.2 Econometric results for factors influencing farmer awareness of water institutions

With reference to Table 12 and 13, all the regression models estimated for farmers awareness of formal and informal water institutions were all statistically significant (p= 0.0001) implying that all the explanatory variables included in the models jointly had a meaningful influence on farmer awareness of formal and informal water institutions in MRIS, TFIS and NIS. The Variance Inflation Factors (VIF) estimated to test for multicollinearity among variables were all less than 10, indicating that multicollinearity was not a serious problem in the data set (Gujarati & Porter, 2009). Moreover, heteroscedasticity was accounted for by using robust standard errors in the OLS regression.

4.4.2.1 Factors influencing farmer awareness of formal water institutions in smallholder irrigations schemes

The regression model had an R-squared equal to 0.2489 implying that 24.89% of the variation in farmer awareness of formal water institutions is explained by the explanatory variables

included in the model. The regression results indicated that among the explanatory variables included in the model, gender, level of education acquired, water management training, scheme location and farmer engagement in scheme decision making processes had positive and significantly influence farmer awareness of formal water institutions, except scheme location which had a negative association with farmer awareness of formal water institutions.

The estimated coefficient of gender was found to be positive and statistically significant (p=0.05) as anticipated. This suggests that male irrigators were more aware of formal water institutions than female irrigators by 0.464, ceteris paribus. Cheteni (2016) found a positive association between gender and farmer awareness of biofuel crops. He argued that male farmers have a higher propensity of obtaining information faster than female farmers, and thus tend to have a higher level of awareness on agricultural activities or innovations.

Table 12. Factors influencing farmer awareness of formal water institutions in Mooi River, Tugela Ferry and Ndumo irrigation schemes, 2018

FORMAL_INSTI	**Coefficient**	**Robust Std. Error**	**VIF**
AGE	0.001 ^{NS}	0.004	1.43
GENDER	0.464 ***	0.184	1.35
EDUC_LEVEL	0.276***	0.084	1.56
SCHEME_LOC	-0.481***	0.294	1.36
WATM_TRAN	0.392***	0.142	1.09
ROLE_SCHMLED	0.057 ^{NS}	0.171	1.14
GOVT_INV	-0.012 ^{NS}	0.030	1.13
TRIBAUTH_INV	0.043^{NS}	0.035	1.06
INV_SCHMDEC	0.106**	0.042	1.19
INFO_SOURCE	-0.048 ^{NS}	0.055	1.19
_cons	-0.436 ^{NS}	0.608	
Model Summary	F-stat = 8.48; p = 0.001 R^2 = 0.2489 n= 274		Mean VIF = 1.25

*Note: *** = p <0.01; ** =p < 0.05; * = p <0.10 and NS= not statistically significant*

Source: Survey data (2018)

A statistically significant (p=0.01) and a positive association between the level of education and farmer awareness of formal water institutions was found as anticipated. Irrigators with a higher level of education were more aware of formal water institutions by 0.276 than those with no formal education, ceteris paribus. According to Duhan & Singh (2017), the level of education directly influences the level of awareness and the correlation between education and awareness level is high. They found a positive relationship between the level of education and farmer awareness of crop insurance.

The estimated coefficient of scheme location was found to have a negative and statistically significant (p=0.10) relationship with farmer awareness of formal water institutions. Irrigators in Msinga Local Municipality are less aware of formal water institutions than irrigators in Jozini Local Municipality by 0.481, ceteris paribus. This significant discrepancy between farmers awareness across these locations could be associated with differences in the accessibility of information and different sources of information.

A statistically significant (p=0.001) and positive relation was found between farmer awareness of formal water institutions and water management training. Irrigators who have received water management training were more aware of formal water institutions by 0.392 compared to those who have not received the training.

The estimated coefficient of farmer involvement in scheme decision making processes was found positive and statistically significant (p= 0.05) as anticipated prior. An increase in farmer involvement in the scheme decision-making processes increases farmer awareness of formal water institutions by 0.106 ceteris paribus. Participation in decision-making processes in the scheme makes irrigators to be aware and updated about new water laws implemented at the central level, given that the scheme committee is also aware of formal water institutions.

4.4.2.2 Factors influencing farmer awareness of informal water institutions in smallholder irrigations schemes

The regression results presented in Table 13 shows that the availability and the effectiveness of the scheme committee in water management was significantly influenced by scheme location (SCHEME_LOC), membership in WUA (WUA_MEMB), government involvement in SISs (GOVT_INV), tribal authority involvement in SISs (TRIBAUTH_INV) and farmer involvement in scheme decision making processes (INV_SCHMDEC). The R^2 for the first regression model is 0.3042 implying that 30.42% of the variation in the availability and effectiveness of the scheme committee in water management is explained by the explanatory variables included in the model.

Farmer awareness of the existence and effectiveness of the scheme constitution in water management as an indicator of informal water institutions was statistically influenced by the gender of an irrigator (GENDER), water management training received (WATM_TRAIN), membership in WUA (WUA_MEMB), farmer involvement in scheme decision making processes (INV_SCHMDEC) and the source of information (INFO_SOURCE). The R^2 for the regression model is 0.1590 implying that 15.90% of the variation in the existence and

effectiveness of the constitution in irrigation water management is explained by the explanatory variables included in the model.

Scheme location (SCHEME_LOC), membership in WUA (WUA_MEMB), farmer involvement in the scheme decision-making processes (INV_SCHMDEC) and the source of information (INFO_SOURCE) had statistically significant influence in rule enforcement in the scheme. The R^2 for the model is 0.1745 implying that 17.45% of the variation in rule enforcement in the scheme is explained by the explanatory variables included in the model.

Table 13. Factors influencing farmer awareness of informal water institutions (SCHEME_COM, SCHEME_CONST and RULE_ENF) in Mooi River, Tugela Ferry and Ndumo irrigation schemes, 2018

	SCHEME_COM		SCHEME_CONST		RULE_ENF		
Explanatory variables	**Coeff.**	**Rob. Std Err.**	**Coeff.**	**Rob. Std Err.**	**Coeff.**	**Rob. Std Err.**	**VIF**
AGE	0.000^{NS}	0.007	0.000^{NS}	0.006	0.004^{NS}	0.006	1.45
GENDER	-0.005^{NS}	0.215	0.615**	0.250	-0.130^{NS}	0.181	1.38
EDUC_LEVEL	-0.127^{NS}	0.106	0.132^{NS}	0.112	0.119^{NS}	0.098	1.60
SCHEME_LOC	-0.478*	0.294	0.139^{NS}	0.322	0.458**	0.221	1.45
WATM_TRAN	0.051^{NS}	0.168	-0.291*	0.156	0.126^{NS}	0.147	1.11
ROLE_SCHMLED	-0.291^{NS}	0.161	0.281^{NS}	0.221	0.097^{NS}	0.161	1.14
WUA_MEMB	-1.174***	1.441	0.944**	0.419	-0.733*	0.375	1.12
GOVT_INV	0.242***	0.041	-0.021^{NS}	0.040	0.018^{NS}	0.038	1.13
TRIBAUTH_INV	0.238***	0.051	0.008^{NS}	0.056	-0.027^{NS}	0.048	1.07
INV_SCHMDEC	0.449***	0.072	-0.154**	0.067	0.181***	0.059	1.19
INFO_SOURCE	-0.053^{NS}	0.076	-0.266***	0.069	-0.393***	0.064	1.19
_cons	7.807***	0.989	1.953*	1.055	-0.003^{NS}	0.861	
Model Summary	F-stat = 10.17; p = 0.001 R^2= 0.3042 n= 274		F-stat = 4.40; p = 0.001 R^2= 0.1590 n= 274		F-stat = 4.92; p = 0.001 R^2= 0.1745 n= 274		Mean VIF= 1.26

*Note: *** = p <0.01; ** =p < 0.05; * = p <0.10 and NS= not statistically significant*

Source: Survey data (2018)

a)The availability of the scheme committee

The positive and statistically significant (p= 0.001) association between government involvement in SISs, tribal authority involvement in SISs, farmer involvement in scheme decision making processes and farmer awareness of the availability and effectiveness of the scheme committee in water management is consistent with the study expectations. The

government through extension officers, the traditional leaders, irrigators and the scheme committee often work together to overcome water-related issues and to develop effective water management strategies. Therefore, the involvement of government involvement and tribal authority in SISs and the involvement of farmer in scheme decision-making processes improves the effectiveness of the scheme committee in water management. Hence, traditional leaders, scheme irrigators and government department are more aware of informal water institutions.

The statistically significant (p= 0.10) negative association relationship found between scheme location and farmer awareness of the availability of the scheme committee could be attributed to the severity of water supply challenges and irrigator's lack of respect of the scheme rules regarding the accessing of irrigation water in Msinga. This makes it difficult for the scheme committee to its functions successfully. A statistically significant (p= 0.001) and negative relationship found between membership in WUA and farmer awareness of the availability and effectiveness of the scheme committee in water management can be because WUAs did not exist in the study irrigation schemes.

b) The existence of the scheme constitution

Male irrigators understand the constitution of the scheme better than female irrigators and perceived the operational rules stipulated on it to be effective in water resource and scheme management. This is because in rural areas leadership is considered as men's task (Akroush & Telleria, 2013). Moreover, men cultivate bigger plots as they regard farming as a business, hence are more likely to hands-on in scheme and thus, more aware of the informal water institutions as anticipated. Although irrigators in the study irrigation schemes were not WUA members, the statistically significant association between membership in WUAs implies that membership in WUAs improves farmer awareness of the scheme constitution since the WUAs are established on the same setup as traditional irrigation schemes.

An association between water management training, farmer involvement in the scheme decision-making processes, the source of information and farmer awareness of the scheme constitution and its effectiveness in water management contradicts the study expectations. The descriptive statistics indicated that most irrigators participated in the scheme decision-making processes. Likewise, water management training received by the scheme irrigators was informal and provided by the scheme committee and fellow farmers. In this way, irrigators could be informed with water management strategies documented in the constitution. The

negative relationship could mean that irrigators were not informed about the scheme constitution during the training. Among the information sources of the scheme irrigators, the irrigation committee and fellow farmers could disseminate information about the scheme committee. However, during the survey irrigators were only asked about their sources of agriculture-related information which could be the reason for the negative association between information source and the awareness of the scheme constitution.

c) Enforcement of rules in the scheme

A positive association was found between the location of an irrigation scheme, farmer involvement in the scheme decision making processes and farmer awareness of rule enforcement in the scheme. Irrigators in irrigation schemes in Msinga and farmers who participate in scheme decision-making processes are more likely to be aware of the rule enforcement in the scheme. This is because there are high incidents of unlawful behaviour and water conflicts in Msinga irrigation schemes compared to Jozini irrigation schemes. It is often difficult to report unlawful behaviour and impose penalties on irrigators due to fear of being killed, however, there are some case where irrigators are disciplined, and matters taken to traditional leaders. In this way, irrigators become aware that rules are enforced in the scheme. During the decision-making process issues of noncompliance are often discussed, the possible punishments to be imposed and the effective ways of enforcing rules in the scheme.

The source of information does not inform irrigators about rule enforcement in the scheme, likewise, since WUAs is non-existence in the study irrigation schemes membership in WUA does not rise farmer awareness about rule enforcement in the scheme.

4.5 Conclusion and Recommendations

The study concludes that formal water institutions are unknown at the farm level, reflecting insufficient communication between government and irrigators. Instead, irrigators in SISs rely on informal institutional arrangements for water management, and these informal institutions work effectively. Formal water management institutions such as WUAs are unknown and non-existent. Results revealed that male irrigators were more aware of both formal and informal institutions than their female counterparts. This could be attributed to customary laws and social norms which promote patriarchal power and limits women from participating in public organizations, local water governance and decision-making processes as traditionally, they are expected to do homestead activities. Age of irrigator did not influence farmer awareness of

both formal and informal water institutions in Mooi River, Tugela Ferry and Ndumo irrigation scheme.

The study recommends that informal water institutions should be given recognition as they have proven to be effective in water resource management in SISs and to be more relevant to the local needs than Statutory water laws. In addition, customary laws must be incorporated when formulating national laws since irrigators tend to comply with rules locally set by traditional leaders. For the NWA to achieve its goals, the study suggests more efforts should be on raising farmer awareness to formal water institutions, what they entail and their aims.

4.6 Summary

The water policy for irrigation in South Africa has transformed over the years and smallholder irrigators might not be aware of them. This chapter assessed and identified factors influencing farmer awareness of water governance dimensions across intergenerational and gender dimensions in Mooi River, Tugela Ferry, and Ndumo irrigation schemes. Water governance dimensions were broken down into formal and informal water institution indices generated by PCA. Findings indicated that formal water institutions were unknown, hence, there was a high reliance on informal institutions. Factors influencing farmer awareness of water governance dimensions included gender, level of education, scheme location, membership in WUAs, stakeholder participation and farmer's involvement in scheme decision-making processes. Age did not influence farmer awareness of water governance dimensions. The subsequent chapter focus on the third objective of the study.

CHAPTER FIVE: THE EFFECTS OF GOVERNANCE ON CROP ALLOCATION IN SMALLHOLDER IRRIGATION SCHEMES: A CASE OF KWAZULU-NATAL PROVINCE, SOUTH AFRICA

Abstract

Land and water resources are fundamental inputs for agricultural production and their management partly determines farm profitability. They are key for poverty alleviation and improved rural livelihood among smallholder irrigators. However, both resources have been falling, thus increasing the need for farmers to intensify farming and to make informed choices about the allocation of land to various crops. Irrigation is often constrained by the physical water supply or institutions, which may force irrigators to reduce the amount of irrigated land. It is therefore critically important to understand institutional settings that determine land and water availability and their influence on farmer decisions.

This study investigates the effects of governance and other factors on crop choice and land allocation decisions across in smallholder irrigation schemes in KwaZulu-Natal, South Africa, i.e., Mooi River, Tugela Ferry and Ndumo irrigation schemes. The study applied the Fractional Logit Generalised Linear Model, and results indicated that age of an irrigator, size of a plot, type of land ownership, access to credit, revenue (farm income), and irrigation water significantly influenced cropland allocation decisions.

The study recommends that government and policymakers develop agricultural policies and laws capacitate smallholder farmers to make informed production decisions, thereby improving farm incomes and welfare.

5.1 Introduction

Land and water resources are fundamental inputs for agricultural production and their management partly determines farm profitability (Sauer *et al.*, 2008). The resources are key for poverty alleviation and improving rural livelihood among smallholder irrigators (Namubiru-Mwaura, 2014). However, both are increasingly scarce due to land degradation emanating from increasing population growth and increasing competition for water resources from industrial sector (Purushothaman *et al.*, 2013). This raises concerns about food security and the future for agricultural production. Agriculture is important for achieving food security and for an alternative way to realise income (Adjimoti, 2018).

Despite the scarcity of agricultural land and water, farmers have to remain in production to feed their families and an increasing population anticipated to double by 2050 in Sub-Saharan Africa and developing countries (Nguyen *et al*., 2017; Amare *et al.,* 2018). Farmers must find ways to balance opportunities against constraints and achieve maximum payoff (utility and/ profit). Hence, there is a need for farmers to intensify farming and to make informed choices about cropland allocation (Thamaga-Chitja & Hendriks, 2008; Ruoff, 2015). According to Dury *et al.* (2012) decisions that farmers make on crop-choices and land allocation determine both their short- and the long-run productivity and profitability.

Generally, agricultural decisions are made under uncertainty and risks associated with anticipated future rainfall (which affects water availability for irrigation and water security), market (output) prices, changes in agricultural policies, an outbreak of pests and diseases (Thamaga-Chitja & Hendriks, 2008). Lack of trust between traders, government officials and farmers, and complex institutional structure create challenges for farmers to obtain accurate agricultural information which leads to uninformed decision making at farm level (Premarathne, 2012; Samaniego *et al*., 2017). Premarathne (2012) and Wood *et al.* (2014) asserted that perfect information on irrigation water availability, market prices and environmental risks from formal and informal institutions are essential for efficient resource allocation and increased adaptation. Changing norms and cultural aspects in the community further create uncertainties for farmers as it has been realised that informal institutional factors heavily influenced social behaviour and decisions in communities where livelihood is derived from agricultural activities is (Premarathne, 2012; Kuil *et al.,* 2018).

Farmers allocate their land among different crops based on resource availability. Where profit maximization is the primary objective, farmer decisions are motivated by expected revenue, affordability of necessary inputs (Sauer *et al*., 2008; Porgo *et al*., 2018). Hence, they rationalise to realise the desired utility level. In the irrigated crop production, farmers base their crop-choice and land allocation decisions on the availability of irrigation water (Adjimoti, 2018). In Uganda, Ruoff (2015) found that optimized resource allocation varies strongly across farmers. It is therefore important to understand how farmers make decisions on resource allocation in their plots.

Although biophysical factors are known to be principal factors influencing crop choices and land allocation decisions, institutional factors and agricultural policy (e.g. subsidy programs) should not be ignored as they also play an important role in cropland allocation decisions

(Ndhlovu, 2010). More attention has been put on agronomic factors, technical factors, etc while the effects of institutions on the performance of smallholder farmers have been overlooked (Moswetsi *et al.,* 2017). This is indicated by minimal literature existing on the studies investigating the effects of governance on crop choice and land allocation decisions indicating the existence of a knowledge gap on this aspect. Therefore, this study investigates the effects of governance and other factors on crop choice and land allocation decisions across in smallholder irrigation schemes in KwaZulu-Natal, South Africa, i.e., Mooi River, Tugela Ferry and Ndumo irrigation schemes.

5.2 Governance and Cropland Allocation Decisions

Although irrigation water has been widely recognised for its significant role in increasing production yields (Huh & Lall, 2013), its availability is the key driver of production decisions and the major limiting factor for agricultural development in many smallholder irrigation schemes (SISs) (Rahman, 2008; Duku *et al*., 2018; Moswetsi *et al*., 2017). A limited supply of water resources negatively affects the functioning of agricultural activities and translates to changes in land use patterns at the farm level (Ahmad, 2000). According to Sauer *et al*. (2008) and De Loe & Bjornlund (2010) the prevailing water scarcity and inefficiencies in agriculture results due to the absence of property rights and inadequate water pricing. Purushothaman *et al*. (2013) argued that the prevailing institutions in the agricultural sector, both at the national and farm level drive farm decisions that irrigators make.

North (1999) cited by Murugani & Thamaga-Chitja (2018: 260) define institutions as "formal rules, informal constraints (norms of behaviour, conventions and self-imposed codes of conduct) and the enforcement characteristics of both". According to Global Water Partnership (GWP) (2017: 12), "governance refers to the system of actors, rules, mechanisms, and processes through which land and water are accessed, used, controlled, transferred, and related conflicts managed". Irrigation schemes have both formal and informal institutions. However, the feasibility and effectiveness of governance depend on the level of stakeholder involvement (GWP, 2017). Land and water resources are fixed, allocable resources with institutions and governance governing the use of resources at scheme level (Anaba, 2016).

Irrigators in SISs adopted irrigation scheduling as a tool for improving water use efficiency as it dictates the frequency of irrigation and the volume of water applied (Stevens, 2006). Irrigation scheduling often facilitates water use and management in irrigation schemes whereby irrigators take turns to irrigate (Agholor, 2014). Therefore, irrigators base their cropland

allocation decisions on the prevailing irrigation scheduling arrangement. According to Lamm *et al.* (1993), irrigation can either be constrained by physical water supply or institutional constraints which may force irrigators to reduce the amount of land under irrigation. Irrigators from Chakohwa and Nenhowe irrigation schemes in Zimbabwe revealed that the scheme irrigation water rules and practices affected their field activities and production decisions through the uncertainties of water availability (Samakande *et al*., 2002).

Farmers consider the tenure status of their land when making farm decisions, particularly those involving investments in productivity-enhancing or soil conservation technology (Place & Otsuka, 2002). According to Agholor (2014), tenure security influences the short-term and long-term farmer decisions on land use and determine a household's ability to remain in farming. Land tenure system and individual land rights under traditional authorities and customary laws are considered as weak and insecure. They distort farmer's incentives to make substantial agricultural investments (Place & Otsuka, 2002; Adjimoti, 2018). Hence, modern, efficient and transparent land tenure system is essential (Adjimoti, 2018). This study postulates that governance on irrigation practices determine farmer's crop choices.

5.3 Methodology

This section provides the research methods used in the study. It briefly describes the study area, sampling and data collection techniques, as well as data analyses.

5.3.1 Conceptual framework

The conceptual framework discussing the interaction between irrigators and governance in irrigation schemes have been provided in chapter 3, section 3.2.1.

5.3.2 Study area

The survey was undertaken in MRIS, TFIS in Msinga Local Municipality in uMmzinyathi District and NIS in Jozini Local Municipality in uMkhanyakude District. MRIS covers approximately 600 ha made up of 15 blocks, which serves about 850 irrigators. The scheme primarily depends on the Mooi River for water and uses the canal to convey water to the field. TFIS has the highest number of beneficiaries (1500 irrigators). It covers approximately 800 ha made up of 7 blocks. The scheme is fed by Tugela River and uses the canal, diesel, and electric pumps to convey water to the field. Finally, NIS is a relatively large irrigation scheme (approximately 1500 ha comprising of Phase 1 and 2) serving relatively fewer beneficiaries

(100 irrigators) compared to the other irrigation schemes. With respect to water abstraction, the scheme abstract water from Pongola River and convey it to the plots through an electric pump.

All respondents in this study were irrigators, and all grew food crops. In MRIS potatoes, tomatoes, garlic and beans dominated the crops grown. Maize, potatoes, tomatoes and sweet potatoes were the most cultivated crops in TFIS. While in NIS major crops were chillies, cabbage, green pepper, beans, tomatoes and butternut (Survey data, 2018). Other vegetables such as onions, spinach, etc. were grown in a smaller portion of land for household consumption. The availability of the output market and the ability of the produce to increase household calorie availability and income informed the choice of crops grown in these irrigation schemes, especially in Msinga where farming is for subsistence. However, the land is a major limitation since farmers cannot acquire more land in the scheme. In MRIS irrigation water is another constraint due to the severity of water scarcity and lack of reliable water supply, particularly for tail end blocks in the scheme.

5.3.3 Data collection methods and sampling techniques

Data collection methods and sampling techniques used in the study were discussed in chapter 3, section 3.2.2. However, in this chapter, only a sample of 259 (~11% of the population of irrigators) irrigators was drawn from the three irrigation schemes by selecting every seventh irrigator.

5.3.4 Analytical framework

Farmers have different aspirations and motives for engaging in farming (Mwaura & Adong, 2016). While some consider farming as a business, others regard it as the main source of livelihood. This is because the farmers are both producers and consumers of agricultural production and therefore production and consumption decisions cannot be modelled in isolation as they are linked (Ndhlovu, 2010; Mwaura & Adong, 2016; Turner, 2014). Therefore, this study adopted the utility theory (Adjimoti, 2018), where the assumption is that all households want to maximize utility given the constraints and opportunities associated with their choices.

Utility theory

According to Ndhlovu (2010); Samaniego *et al.* (2017); Adjimoti (2018); Kuil *et al.* (2018); and other authors smallholder farmers seek to maximise their anticipated utility (U) which is a function of consumption of agricultural goods (X), consumption of purchased (non-agricultural) goods (Y) and a function of leisure (H). The utility maximised is subject to cash

budget constraint which is the costs of consumption, determined by input (P_x), output ($P_{y)}$ prices and transaction costs for buying (TC_b), is less than or equal to profits from non-agricultural activities (π_y) and profit from crop production, which is equal to this value of production (P_xQ) minus the cost of inputs (P_vV), the transaction costs of selling agricultural goods (TC_{by}) and buying agricultural inputs (TC_{bv}). Farmers also face production constraint for which output is a function of farm labour (F), other variable inputs (V), land area (A), capital (K) and risk (σ). Moreover, the choices that farmers make are further constrained by time which limits the sum of farm labour, leisure and off-farm labour (O) to be less than time endowment T. X, Y and Q are non-negative values. This can generally be expressed as follows:

$Max\ U = f(X, Y, H)$: Utility maximization

$P_xX + TC_{bx} + P_yY + TC_{by} \leq P_xQ - TC_{sx} - P_vV - TC_{bv} + \pi_y$: Budget constraint

$Q = f(F, V, A.K, \sigma)$: Production constraint

$T = H + F + O$: Time constraint

$X, Y, Q \geq 0$ (1)

The decisions on the share of land allocated to various crops will depend on all variables that lead to specialization in one crop or diversifying production to different crop enterprises. Such variables include inputs, labour, total land available, household's socio-economic characteristics, expected prices, income generating activities, physical conditions in the area, transaction costs, risk and profits from other activities (πy).

The reduced form-land allocation function can generally be presented as follows:

$\text{Reduced} - \text{form land allocation function}: \quad Q_j = f(P, F, V, A, K, \sigma, TC, Hh, \pi y)$ (2)

5.3.5 Empirical Model

Fractional Logit Generalised Linear Model

Fractional response regression models (either logit, probit or hetprob) were identified as appropriate methods for analysing response variables that proportion in nature, that is, their values range between an interval of zero and one. However, Papke &Wooldridge (1996) and Baum (2008) criticised the use of fractional response models such as logit and probit as they impose the data constraint that the dependent variable must be coded as either 0 or 1. Ordinary Least Squares (OLS) and Tobit regression models were also not suitable for estimating

proportions as they will generally yield senseless predictions for the extreme values (Baum, 2008). They tend to ignore entries with zero, no land allocated to any crop (Samaniego *et al.*, 2017) Papke &Wooldridge (1996) and Baum (2008) then offered Fractional Logit Generalized Linear Model (FLGLM) as the most suitable and reliable method for modelling proportions. FLGLM fills the gap that the logit, probit and hetprob do not allow for fractional response models. According to Wooldridge & Papke (1996), the FLGLM is a quasi-likelihood method of estimating regression models with a fractional dependent variable.

According to Papke & Wooldridge (1996), the FLGLM is a Generalised Linear Model with a binomial distribution and a logit link function) may be presented as follows:

$$g\{E(y)\} = x\beta, y \sim F \quad (3)$$

where $g(.)$ is the link function and F is the distributional family.

This becomes $Logit\{E(y)\} = x\beta, y \sim Bernoulli$ (4)

Principal Components Analysis

Principal Components Analysis (PCA) is a "multivariate technique with the central aim of reducing the dimensionality of a multivariate data set while accounting for as much of the original variation as possible" (Everitt & Hothorn, 2011: 61). It economizes on the number of variables without losing too much information and eliminates the possibility of multicollinearity by replacing the highly correlated variable with few uncorrelated PCs (Jolliffe, 1986). PCA has widely been applied in different subjects to generate indices such as asset index (Wood *et al.*, 2014), water security index (Muchara, 2014) and other researchers. This study also applied PCA to generate governance indices and farmer's perceptions of water governance that were used as explanatory variables in the FLGLM.

The KMO, the measure of sampling adequacy is greater than 0.5 implying that data is suitable to be used in PCA (Table 1) (Kaiser & Rice, 1974). To retain the PCs the study applied the Kaiser criterion which suggests that PCs with eigenvalues greater than one must be retained. Two PCs were retained. Table 14 presents the retained PCs and the proportion of variation explained.

The first PC explains 41.15% of the total variation in water governance. It describes the necessary instruments and bodies for ensuring sustainable use and management of water resources in SISs when satisfaction with irrigation schedule and constraints arising due to

irrigation scheduling move in an opposite direction. Hence, the PC was named water governance (WAT_GOVNC). The second PC explains 16.87% of the total variation in water governance. It describes farmers' satisfaction with irrigation water schedule associated with satisfaction with the scheme committee in ensuring compliance to regulation on water uses and the cooperation between farmers in different Blocks. Hence, it is named farmer' satisfaction with an irrigation schedule (SAT_IRRGSCHD).

Table 14. Principal component analysis of the major indicators of scheme water governance

Description of variables	Principal Components	
	PC1	PC2
• Satisfaction with irrigation schedule	-0.014	**0.860**
• Constraints due to the current irrigation water law	-0.260	- 0.708
• The effectiveness of the constitution in water resource management	**0.650**	0.181
• The effectiveness of the scheme committee in ensuring compliance to regulation on water uses	**0.717**	0.300
• Satisfaction with the cooperation between farmers in different blocks	**0.519**	0.498
• Farmer participation in formulating irrigation water schedule	**0.769**	-0.060
Eigenvalue	2.469	1.013
Variance explained	41.150	16.877
Cumulative percentage of variation explained	58.027	
KMO measure of sampling adequacy	0.776	
Bartlett's test of sphericity	$\sim\chi^2 = 243.582$***	

*Note: Component loadings greater than |**0.40**|are highlighted in bold print*

Source: Survey data (2018)

5.3.6 Description of variables

Dependent variable

The proportion of land allocated to various crops (LAND_ALLOC) was used as a proxy for cropland allocation decisions. It was computed as $P_i = \frac{Ai}{A_i + F_i}$ (5)

Where P_i is the proportion of land cultivated by ith irrigator in winter season where water is scarce; A_i is the area cultivated in winter by an ith irrigator; while F_i is the area fallowed; for $i = 1, 2, \ldots, n$ (number of irrigators) (Malik & Singh, 2002). The index of land allocation ranges between the zero – one interval, where a share of 0 means imply that nothing was allocated on a given land area while 1 means that the total landholding was fully cultivated. A value above 1 is empirically impossible (Papke & Wooldridge, 1996; McCord, 2015; Cobourn *et al.*, 2017).

Factors influencing cropland allocation decisions

Studies conducted on crop choice and land allocation decisions specifically assessing factors influencing land-use intensity, crop diversification, crop choices, cropland allocation decisions, etc in different countries used different approaches and empirical models to estimate the relationships. The statistically significant drivers of crop-choice and cropland allocation decisions at the farm level were:

- Level of education, farming experience, farm asset ownership and off-farm income (Rahman, 2008);
- Average home to plot distance in km, consumer-worker ratio, female labour, total household livestock units, a log of household total real asset value, the degree of land fragmentation, region, and access to fertilizer subsidy (Ndhlovu, 2010);
- Amount received from leasing, value adding to products, annual farm income, savings, skills pertaining to farming activities and the proportion of farm inputs purchased with the farmer's own money (Tshilowa, 2015);
- Household location within sub-regions, size of cultivated land, distance to output markets and education levels of household head (Mwaura & Adonga, 2016);
- Age, education, land size, agricultural labour, distance, infrastructure, credit access and dependency ratio (Nguyen *et al*., 2017); and
- Weather shocks (particularly rainfall), household characteristics, plot characteristics and road accessibility (Amare *et al.,* 2018).

Empirical evidence on studies conducted on land allocation decisions informed the choice of explanatory variables included in the analysis. These variables can have a negative or positive effect on land allocation decisions. The effects of governance on land allocations differ among irrigators due to heterogeneity existing among irrigators in terms of their vulnerability and resilience. Therefore, heterogeneity in farmers with regards to household assets and wealth provide adaptation strategies for farmers (Wood *et al.,* 2014). Murugani & Thamaga-Chitja

(2018) pointed out five types of assets: natural assets (land, water quantity and quality); physical assets (tools and equipment, transportation, roads, buildings, technology and communication); financial assets (credit); human assets (skills, knowledge, capacity for value chain activities and labour power; and social assets (group membership and relationships of trust and reciprocity, linkages to buyers and service providers, and linkages to decision makers). Based on the empirical evidence and literature reviewed the study used the explanatory variables described in Table 15 as the key drivers of cropland allocation decisions.

Table 15. Description and a prior expectation of the explanatory variables included in the regression analysis

Variable name	**Description**	**Expected effect**
Dependent variable		
LAND_ALLOC	An index of the proportion of land allocated to various crops	
Explanatory variables		
AGE	The age of an irrigator (continuous: years)	+/-
GENDER	The gender of an irrigator (dummy: 1= male, 0= otherwise)	+
EDUC_LEVEL	The level of education an irrigator has obtained (categorical: 1= no formal, 2= primary, 3= secondary, 4= tertiary)	+
HHOLD_MEMB	The number of household members (continuous)	+
LAND_SIZE	The total amount of land held	+
LOCATION	Local Municipality where the irrigation scheme is located (dummy: 1 = Jozini, 0 = Msinga)	+
ACCESS_CRED	Whether an irrigator have access to credit (dummy: 0 = No, 1 =Yes)	+
REVENUE	The amount of income received from irrigated farming (continuous: Rands per season)	+
WATSUFFCNY	Farmer perceptions on whether the amount of irrigation water received was sufficient for crop requirement (Likert scale: 1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree)	+
WAT_GOVNC	Water governance (index)	-
SAT_IRRGSCHD	Satisfaction with irrigation schedule (index)	+

Source: Agholor (2014); Chirigo (2014); Mdletshe (2014)

Age: Age is an important element in the farm decision-making process. Older farmers are better-equipped with farming skills, more familiar with the physical environment surrounding farming and can easily evaluate available opportunities (Agholor, 2014; Chirigo, 2014). Bembridge (1984) cited in Agholor (2014) state that as the age increases, farmers become more reluctant to change and stick to conservative methods. On the contrary, younger farmers adapt easily to changes either on the environment or agricultural institutions as they are willing to adopt new innovations. Hence, age is likely to positively or negatively influence cropland allocation decisions.

Gender: Gender of an irrigator is generally associated with accessibility of agricultural resources and knowledge, and socio-cultural norms in patriarchal countries create gender discrepancies in agricultural information access (Lamontagne-Godwin *et al.,* 2018). Hence, men are more resilient to shocks and easily adapted to changing environments than women. Holding other factors constant, male irrigators are less likely to allocate more land into cultivation under unfavourable conditions than women.

Level of education: The level of education acquired is a vital element that enables farmers to make informed decisions relating to input selection, crop choice and cropping pattern (Ndhlovu, 2010; Chirigo, 2014; Dossah & Mohammed, 2016). Farmers with a higher level of education tend to explore widely the pathways of getting information about agriculture, expected price and profitability, and the use of modern technologies such as new seed varieties and fertilizers in order to expand their product portfolios (Ndhlovu, 2010; Chirigo, 2014). However, educated farmers people make decisions not to use land when the situation will not realise meaningful production. Hence, irrigators with a high level of education are less likely to allocate more land into cultivation where water stresses are high, ceteris paribus.

Household size: Household size affects land allocation in two ways, that is, food demand and labour. Household size can be used as a proxy for the availability of family labour to work on the farm since smallholder farmers heavily rely on family labour to carry out agricultural activities (Mdletshe, 2014; Dossah & Mohammed, 2016). An additional household member increases food requirement and the scale of production must increase (Porgo *et al.*, 2018). Hence, an increase in household size increases the proportion of land cultivated, ceteris paribus.

Land size: An increase in land size generally increases the proportion of land allocated to alternative crops. However, it can also have negative effects on different crops due to limited production resource (Ndhlovu, 2010). The hypothesis in this study is that irrigators with

relatively larger land holdings are more likely to allocate a large proportion of their land to various crops, holding other factors unchanged.

Access to credit: Credit plays in agricultural production as it allows farmers to secure inputs on time and to finance improved seed varieties (Chirigo, 2014). Therefore, it is hypothesised that irrigators with access to credit are anticipated to cultivate a large proportion of their land relative to their counterparts.

Revenue: Farmers make decisions to allocate their scarce resources based on relative market prices and expected revenue and are said to be motivated by the amount of profit that can be maximized from certain crops (Sauer *et al*., 2008; Allen, 2012; Porgo *et al*., 2018). Higher revenue irrigators are able to use profit in search for and adoption of possible strategies to overcome water scarcity problems. Hence, irrigators who obtained higher revenue from the previous season compared to their counterparts will allocate larger proportions of land into cultivation, ceteris paribus.

Location of an irrigation scheme: The location variable is used as a proxy for unobserved biophysical factors in the two areas, for example, the severity of water scarcity. The location also represents differences in farm sizes and governance regimes. The study anticipates that irrigators in the area where there are favourable biophysical conditions for farming will allocate more land into cultivation.

Water sufficiency: The availability and distribution of irrigation water that sufficiently meets crop water requirement at various growth stages indicate efficiency in water allocation and enable farmers to increase land cultivated (Basiri, 2009). Therefore, a positive association between water sufficiency and land allocation decisions is anticipated.

Water governance and irrigation water law: SISs use communal water for irrigation which is regarded as a common pool resource (McCord, 2017). For better management of water; efficient and sustainable use of irrigation water, irrigators agree with scheme leaders on the irrigation arrangement that reflects fairness in water accessibility. Irrigators who are satisfied with irrigation schedule (irrigation water law) will continue farming and allocate more cropland into farming relative to their counterparts, ceteris paribus. Irrigation can either be constraint by physical water supply or institutional constraints which may force irrigators to reduce the amount of land under irrigation (Lamm *et al.,* 1993). Therefore, holding other factors unchanged, favourable water governance is anticipated to have a positive effect on cropland allocation decisions.

5.4 Results and Discussion

This study employed both the descriptive statistics and econometric model to analyse data. While the descriptive statistical technique was used to summarize data using mean, frequencies and chi-squared (χ^2) tests, the FLGLM was applied to estimate the effects of governance and other factors on cropland allocation decisions across gender and intergenerational dimensions.

5.4.1 Descriptive statistics

Household Characteristics

MRIS and TFIS were dominated by female and elderly irrigators as reflected in Table 16. The average of irrigators was 57 and 55 years in MRIS and TFIS, respectively. In addition, most irrigators in MRIS and TFIS had no formal education, very few had reached the high school level. On the contrary, NIS was dominated by male and young irrigators. The average age of irrigators in the scheme was 46 years. Most irrigators had acquired formal and a considerable percentage had reached high school and tertiary level education.

Table 16. The distribution of age and education level across irrigation schemes

Variable	Description	Irrigation Scheme			χ^2
		MRIS (n= 120)	TFIS (n= 105)	NIS (n= 34)	
Gender	Female (%)	84.2	86.7	32.4	***
	Male (%)	15.8	13.3	67.6	
Age group (years)	21-35 (%)	21.7	22.9	47.1	**
	36-56 (%)	23.3	27.6	23.5	
	57-69 (%)	23.3	26.7	17.6	
	70-88 (%)	31.7	22.9	11.8	
Education level	No formal (%)	64.7	55.2	23.5	***
	Primary (%)	19.3	32.4	23.5	
	High school (%)	13.4	12.4	32.4	
	Tertiary (%)	2.5	0.0	20.6	

*Note: ***= p <0.01; **= p <0.05*

Source: Survey data (2018)

Land

In line with Murugani & Thamaga-Chitja (2018) women constituted the largest proportion of irrigators yet occupy relatively small land sizes while men had and relatively few of them occupied land registered in their names. Most of them use land registered in their male kins'

names. In this study, women had a mean land size of 0.49 ha while it was 2.16 ha for men. With respect to land ownership, most men (77.7%) occupied land registered in their names relative to women (43.3%).

Access to credit

Most irrigators across the study irrigation schemes could assess credit to finance their production (49.2% (MRIS); 62.9% (TFIS); 76.5% (NIS)). However, most of them relied on the informal institution. About 41.7%, 20.0% and 3.8% irrigators from NIS, TFIS and MRIS, respectively who could secure credit from formal financial sources. This was due to the lack of collateral among farmers as they lack ownership of the land they held. According to Murugani & Thamaga-Chitja (2018), lack of collateral impedes the chances for farmers to acquire financial assistance from Banks.

Water governance

Irrigation water availability and accessibility were not uniform across the study irrigation schemes due to differences in the irrigation infrastructure used, the prevailing irrigation water law (irrigation schedule) or the severity of water shortage in the area. MRIS irrigators received relatively less water than the other irrigation schemes. On average, irrigators from MRIS, TFIS and NIS received water once a week, twice a week and 5 days per week, respectively. Moreover, only 23.3% irrigators from MRIS who perceive the amount of water received as adequate for their crop requirements while 93.3% and 97.1% from TFIS and NIS, respectively.

With reference to Table 17, most irrigators across the study irrigation schemes were satisfied with the irrigation schedule, had no constraints with the irrigation schedule except in MRIS (40.0% (MRIS); 17.1% (TFIS) & 11.8% (NIS)), and perceived that informal irrigation water law influences their decisions on resource allocation and cropping patterns. Moreover, irrigation water law was perceived as effective in managing water resources in the schemes. The responses from irrigators showed statistically significant variations across irrigation schemes, implying that the effects of irrigation water law differ across.

The statistically significant influence of irrigation water law in resource allocation and cropping pattern associated with household resource endowments has led to poor land utilization during the times when water stresses are high. Results obtained from the household survey showed that 69.3% irrigators cultivated their land, although not all of them utilised their

land at full capacity. While 30.1% of irrigators had nothing in their fields during the study. However, it cannot be inferred that this was due to irrigation water law and governance. The fallowed land can also be due to the household's lack of resources or vulnerability to shocks.

Table 17. Farmer perceptions on the influence of informal irrigation water law across irrigation schemes

Farmer's response		SD	D	N	A	SA	χ^2
	Satisfaction with irrigation schedule (%)						
Irrigation scheme	MRIS (n=120)	20.8	31.7	10.8	30.0	6.7	***
	TFIS (n=105)	0.0	3.8	4.8	55.2	36.2	
	NIS (n=34)	0.0	3.0	15.2	63.6	18.2	
	Irrigation water law is effective in managing water resources (%)						
Irrigation scheme	MRIS (n=120)	4.2	12.5	25.0	45.8	12.5	*
	TFIS (n=105)	1.0	13.3	19.0	43.8	22.9	
	NIS (n=34)	0.0	12.1	15.2	66.7	6.1	
	Irrigation water law influence resource allocation decisions (%)						
Irrigation scheme	MRIS (n=120)	4.2	11.7	24.2	42.5	17.5	**
	TFIS (n=105)	1.9	17.1	15.2	38.1	27.6	
	NIS (n=34)	3.0	18.2	15.2	60.6	3.0	
	Irrigation water law influence cropping pattern (%)						
Irrigation scheme	MRIS(n=120)	0.8	15.8	14.2	45.0	24.2	***
	TFIS(n=105)	3.8	21.9	10.5	27.6	36.2	
	NIS (n=34)	0.0	27.3	18.2	54.5	0.0	

*Note: ***= p <0.01; **= p <0.05; *= p <0.10*

SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree

Source: Survey data (2018)

5.4.2 Econometric results for the effects of governance on crop allocation in smallholder irrigation schemes

The VIF used to diagnose multicollinearity among explanatory variables indicated that multicollinearity was not a serious problem since all VIF values were below 10 (Gujarati & Porter, 2009). While heteroscedasticity was automatically corrected for in the model by employing robust standard errors. The estimated Wald chi-squared statistics indicated that the estimated FLGLM model was statistically significant at one percent level, implying that the explanatory variables included in the model jointly explain the variation in the proportion of land allocated to various crops during the periods of water insecurity. Moreover, five variables

out of the eleven included in the model were statistically significant in explaining land allocation decisions. Hence, the model as a whole makes statistical sense.

Out of the eleven variables included in the model, five variables (age of an irrigator (AGE), land size (LAND_SIZE), access to credit (ACCESS_CRED), expected revenue (REVENUE) and water sufficiency (WATSUFFNCY)) were found to have a statistically significant influence on land allocation decisions, while the rest of the variables had no effect. Of the five statistically significant variables, the coefficient estimates of ACCESS_CRED, REVENUE and WATSUFFNCY had positive signs, implying that an increase in either of these variables encourages irrigators to allocate a large proportion of their land into cultivation of various crops. While the estimated coefficients of the other two variables (AGE and LAND_SIZE) had negative signs, implying that an increase in either of these variables reduces the proportion of land allocated to various crops. Table 18 presents the results obtained from the FLGLM differ across the three irrigation schemes in the effects, magnitude and significance.

Table 18. Estimates of the Fractional Logit Generalized Linear Model (n= 259)

LAND_ALLOC	**Coefficient**	**Robust Std. Error**	**VIF**
AGE	-0.018**	0.009	1.38
GENDER	-0.320^{NS}	0.295	1.37
EDUC_LEVEL	-0.133^{NS}	0.157	1.54
HHOLD_MEMB	0.015^{NS}	0.025	1.12
LOCATION	0.603^{NS}	0.601	3.44
LAND_SIZE	-0.183**	0.090	3.02
ACCESS_CRED	0.430**	0.216	1.10
REVENUE	0.000***	3.98e-06	1.55
WATSUFFNCY	0.295***	0.108	1.79
WAT_GOVNC	0.027^{NS}	0.101	1.10
SAT_IRRGSCHD	-0.158^{NS}	0.137	1.71
Cons	-2.214*	1.345	Mean VIF: 1.73
Wald χ^2			33.43
Prob > χ^2			0.0010
Pseudo R^2			0.0571

*Note: ***= p <0.01; **= p <0.05; *= p <0.10; NS= not statistically significant*

Source: Survey data (2018)

Age

As expected, the estimated coefficient of age was negative and statistically significant at p< 0.50. The regression results forecast that for a unit increase in the age of an irrigator the

proportion of land allocated decreases by 0.018, ceteris paribus. Although older farmers tend to have more farming experience than younger farmers, they are less adaptable to environmental changes compared to younger farmers who are more willing to explore and productivity improving adopt innovations (Mdletshe, 2014). During the periods of irrigation water insecurity, younger irrigators can easily adopt drought resistant cultivars. During focus group discussion it was observed that older irrigators treasure indigenous farming methods and are most of them are reluctant to change. Extension officers in Msinga also confirmed this. Hence, during the periods of irrigation water insecurity older irrigators are less likely to allocate their fixed land input into cultivation of various crops.

Land size

The size of land held by an irrigator was statistically significant $p< 0.05$ and negatively related to cropland allocation decisions across irrigation schemes. The model predicts that, for a unit increase in the land size, the proportion of land allocated to various crops decreases by 0.183, ceteris paribus. Small landholding in SISs is one of the limiting factors for the expansion of agricultural production (De & De, 2005). The negative sign in the estimated coefficient could be attributed to the prevailing challenge of unavailability of irrigated land in the scheme. Irrigators who wants to expand their crop production are limited by land since they cannot acquire additional irrigated plots in the scheme since land trading is not permissible and renting of land is insignificant across these irrigation schemes. In addition, Muchara (2014) argued that increasing irrigated land size for crop production increases the demand for reliable water supply which is another limitation for increasing the proportion of land allocated into cultivation of various crops during the period of water shortages. Hence, with small land sizes and limited chances of acquiring additional irrigated as the study findings indicated, irrigators are less likely allocate more land to various crops, instead they will intensify and allocate available land to a single crop that maximizes their utility.

Access to credit

As expected, the estimated coefficient of access to credit (ACCESS_CRED) was positive and statistically significant at $p < 0.50$. Irrigators with access to credit are more likely to allocate land to various crops compared to irrigators without access to credit by 0.430, ceteris paribus. This suggests that irrigators access to credit leads to more access to land to the irrigators when controlling other variable Access to credit allows farmers to secure necessary agricultural inputs and innovative productivity improving technologies (Chirigo, 2014). However,

smallholder irrigators cannot access to credit from formal financial institutions due to lack of collateral (Yobe, 2016).

Revenue

In general, relative prices play a central role in determining crop choices and decisions on the proportion of land to allocate to profitable crops. Higher market prices for farm produce act as motivation for farmers to remain in production and produce more, although these prices can change in the long run (De & De, 2005; Agholor, 2014). In this study, the estimated coefficient of REVENUE was found positive and statistically significant at $p < 0.01$, as expected. The model predicts that for a unit increase in farm income obtained in the previous season, the proportion of land allocated to various crops increases, holding other factors constant. Revenue is a product of output price and the yield, hence farmers as producers are attracted by previous higher output prices and higher yields and allocate a large proportion of land to more profitable crops (De & De, 2005). Unfortunately, smallholder farmers have no or limited access to market information and make production decisions without this important information (Premarathne, 2012; Wood *et al.*, 2014).

Water sufficiency

The estimated coefficient of water sufficiency (WATSUFFNCY) was positive and statistically significant at $p < 0.01$, suggesting that irrigators with irrigation plots where water supply is sufficient for cropping requirements are more likely to allocate land to various crops compared to irrigators with irrigation plots where there is insufficient water supply, by 0.295. Most irrigation schemes face the challenge of inadequate water supply partly due to outdated irrigation infrastructure and erratic rainfall pattern but mostly due to inefficient use of irrigation water. These results are not surprising because during the household survey most irrigators revealed that if the water supply is not disrupted by other irrigators upstream, it is sufficient for their cropping requirements. Such claims about inadequate water supply were an issue of uncalled for behaviour of fellow irrigators resulting from the prevailing global water shortages. De & De (2005) inferred that adequate and timely availability of rainfall and irrigation encourages irrigators to expand crop production. Basiri (2009) and Agholor (2014) also found a positive association between water sufficiency and land allocation decisions.

Gender

The estimated coefficient of gender had a negative association with the proportion of land allocated to various crops. However, this relationship was not statistically significant. This can be attributed to the dominance of female irrigators in the study sample. Holding other factors constant, women have relatively less capital to purchase farm inputs and productivity improving technologies. Also, the degree of land accessibility is lower than that of men. Hence, they are likely to allocate less land into cultivation by 0.320 compared to their male counterparts. Ndhlovu (2010) found that women cultivated relatively less crops on their plots compared to men. Another justification for this could be the fact that most women occupy land that is not theirs, hence allocate their resources in fear that they will be chased out whenever the owner wants the land back.

Perceptions of water governance and satisfaction with irrigation water schedule

The estimated coefficients of farmer perceptions of water governance and satisfaction with an irrigation schedule in the scheme were not statistically significant at neither one, five or ten percent level. The positive association with the farmer perceptions of water governance imply that the scheme water governance dimensions were effective in managing water resources. Governance did not impose limitations on land allocation decisions unlike in SISs in Limpopo province who were affected by institutional framework governing agriculture (Machete *et al.*, 2004).

On the contrary, the irrigation schedule discouraged farmers to allocate more proportion of land to various crops. This is supported by most irrigators across who indicated that their decisions on resource allocation and cropping pattern were influenced by irrigation water laws in the scheme. The effects of irrigation water law were more severe at the tail-end blocks in MRIS where the amount of water received was not enough for their cropping requirements. Moreover, some irrigators revealed that they were cultivating their land at a loss as their crops were not getting water. Irrigators also revealed that they had to sleep on the mountains ensuring that all canal gates were closed in order to be able to irrigate on the next day.

The two variables had no statistically significant effect on land allocation decisions because most of the irrigators from all the study irrigation schemes were satisfied with the scheme governance of water resource and the prevailing irrigation schedule in the scheme and had no constraints with the irrigation water law. In addition, most irrigators across the study irrigation

schemes perceived water governance dimensions in the scheme to be effective in managing water resources.

5.5 Conclusion and Recommendations

Although the decisions on land use revolve around irrigation water availability and other biophysical factors, institutional factors should not be overlooked as they provide smallholder farmers with an opportunity to expand product portfolio by ensuring sustainable use of the scheme resources. However, irrigation water laws designed in SISs can also create constraints to farmer performance by restricting the abstraction of irrigation water at any times other than those agreed on as a scheme. The decline in the limited supply of water imposes a challenge for irrigators to optimally allocate land and water resources to various crops and other uses.

Based on the results obtained, the study concludes that water governance dimensions did not influence cropland allocation decisions in MRIS, TFIS and NIS, and therefore recommends that government and policymakers develop agricultural policies and laws capacitate smallholder farmers to make informed production decisions, thereby improving farm incomes and welfare.

5.5 Summary

This chapter addressed the final objective of the study which investigates the effects of water governance on cropland allocation decisions in Mooi River, Tugela Ferry and Ndumo irrigation scheme using the FLGLM. Three variables (water sufficiency, access to credit and revenue) had a positive and significant influence on cropland allocation decisions. While the age of irrigator and the land size had a negative influence. In addition, there was no statistically significant difference between cropland allocation decisions made by men and women. The following chapter summarises the main findings of the study and provides policy recommendations drawn from the study.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Smallholder irrigation schemes face several challenges hindering them from performing at satisfactory levels. Among the challenges faced is the limited irrigation water supply emanating from scheme governance problems, with weak institutional arrangements that fail to equitably and effectively govern water resources. Unequal distribution of land resources and unequal representation of women in water management and decision-making processes has been noted across gender and intergenerational dimensions. Consequently, the effects of water scarcity vary across the two dimensions, leaving women and youth vulnerable. Hence, this study sought to assess the effects of the interactions between intergenerational and gender dimensions with governance on the performance of irrigators in SIS, in SA. This was carried out through the following specific objectives: to assess the institutional arrangements for water management in SISs; to identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs, and to investigate the effects of governance dimensions on cropland allocation decisions in SISs.

To achieve the objectives of the study, primary data was collected among 274 irrigators from MRIS, TFIS and NIS, and was analysed using different methodologies. The descriptive statistical technique was used to assess the institutional and organisational arrangements for water management in SISs. To identify the determinants of farmer awareness of water governance dimensions across intergenerational and gender dimensions in SISs, PCA and OLS were applied. While FLGLM was employed to investigate the effects of governance on cropland allocation in SISs.

6.2 Conclusions

The study found that formal institutions such as NWA, NWRS, etc. were not known and WUAs were non-existent at scheme level. This resulted in high dependence on informal institutions for scheme and irrigation management across the study irrigation schemes. Factors found to be significant determinants of farmer awareness of water governance dimensions included household characteristics (gender and level of education), scheme location, membership in WUAs, stakeholder participation and farmer's involvement in scheme decision-making processes. On the other hand, the age of an irrigator, access to credit, land size, revenue and

irrigation water sufficiency significantly influenced irrigator's cropland allocation decisions in SISs.

The study, therefore, concludes that;

- Although, the studied irrigation schemes had functional institutional arrangements They relied on informal institutions for scheme and water management with the scheme committee overseeing water management activities. Irrigators did everything on their own with minimal or no government assistance, which is recommended as the SISs are in the IMT era.
- Men were more aware of both formal and informal institutions than women. With respect to the intergenerational dimension, there was no statistically significant difference in the awareness of both formal and informal water institutions between young and elderly irrigators.
- Water governance had no effect on cropland allocation decisions in the study irrigation schemes. This is because farmers, on average, were satisfied with irrigation law and perceived water governance dimensions to effective in water resource management.

6.3 Policy Recommendations

The dominance of elderly farmers in the agricultural sector requires alternative ways to attract young minds in order to maximise the potential of the sector and make it economically viable. Although women are considered as primary users of land and water resources and the major food producers, they remain highly dependent on men for land and other productive resources since men have control over resources. Traditional norms often disregard the potential of women as farmers and decision makers and thus prevent them from participating in public organizations and in decision-making processes. Moreover, men in rural areas are regarded as leaders, hence, it is important to educate them. Therefore, to empower women, customary laws need to be adjusted to give men and women, youth and elderly equal privileges and opportunities especially with regards to land accessibility and control over resources. Land should be made equally available for both genders, and young girls should also be allowed to inherit land, especially those interested in agriculture. This could improve the contribution of agriculture to GDP because youth have innovative ideas and easily adaptto changes than elderly farmers.

Although both formal and informal institutions are essential for effective management of water resources, irrigators perceived informal institutions as more relevant to their needs and thus tend to attract greater compliance than formal institutions. Therefore, it is important that policymakers investigate the effectiveness of informal institutions on water resource management and incorporate customary laws when formulating national laws. Informal institutions which are functional, recognised and in line with irrigation management transfer should be strengthened. Farmers should also be encouraged to deal with scheme matters on their own without relying on government. Moreover, farmer awareness on water policies, government aims, and programmes implemented for effective management of water resources should be improved in order to increase their compliance with formal institutions.

6.4 Study Limitations

It was difficult to obtain precise information on the size of land held, the area planted and other production data due to recalling problem. Despite the study limitations, the research findings and conclusions will help policymakers review whether the policies they have formulated are communicated to the local level, whether smallholder farmers understand these policies and their aims, what has been the impact of these policies to smallholder farmers as well as what improvements can be made to ensure that the intended aims of the water policies are attained in the future.

6.5 Areas for Future Research

The limited availability of literature on the effects of institutional arrangements, smallholder performance and on the interactions between governance, intergenerational and gender dimensions on SISs indicates that there is much scope for future research to fill the institutional gap existing on the analyses of SISs. Further research should investigate the effects of water governance dimensions smallholder economic performance since not much has been done on this aspect.

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APPENDIX 1: HOUSEHOLD SURVEY QUESTIONNAIRE

UNIVERSITY OF KWAZULU-NATAL

School of Agricultural, Earth and Environmental Sciences

Discipline of Agricultural Economics

Effects of interactions between governance, intergenerational and gender dimensions on smallholder irrigation scheme in KwaZulu-Natal, South Africa

Note: All the information provided in this questionnaire is STRICTLY CONFIDENTIAL and will be used for research purposes by staff and students at the University of KwaZulu Natal and Water Research Commission. There is no right or wrong answer to these questions. Moreover, participation in the survey is VOLUNTARY and NO FINANCIAL BENEFITS are paid during or after participation.

QUESTIONNAIRE

Household name	Municipality	District	Date
Irrigation scheme	Block	Interviewer's name	Name of Respondent

**Municipality*: 1= Jozini Local, 2= Msinga Local
**District*: 1= Umzinyathi, 2= Umkhanyakude
**Irrigation scheme*: 1=Mooi River, 2= Tugela Ferry, 3=Makhathini, 4= Ndumo

A: HOUSEHOLD DEMOGRAPHICS (INFORMATION ABOUT THE IRRIGATOR TO BE ENTERED BELOW) (circle the appropriate)

A1. Age Gender: 1=M 0=F Marital status: 1=Single 2=Married 3=Divorced 4=Widowed
A2. Education 1=No formal 2=Primary 3=High School 4= Tertiary
A3. Main occupation 1=Farmer 2=Regular salaried job 3=Temporary job 4=Unemployed 5=Self employed 6=Student 7=Retired 8=Other (Specify)

A4. Total number of household members	
A5. How many of the household members are adults/children?	
A6. How many of the household members work on the farm?	
A7. Do you hire labour to work on the farm? 1= Yes, 0= No	

** Household head refers to the household head that stays in the household for 4 or more days per week*
*** Please include only those who stay in the household for 3 or more days per week*

B: TRAINING

B1. What training have you had?

Training	**1=Yes; 0=No**	**Training provider**
Agriculture		
Irrigation		
Water management		

B2. Which training did you find most useful on the farm?.....
B3. If no in any of the above, do you need training? 1=Yes; 0=No

C. ASSET OWNERSHIP

C1. Household asset: Indicate agricultural production assets that you have access to:

Asset	Quantity/ Number of items owned	Do you consider the production assets you have to be adequate for your Agricultural Activities*: 1= Yes; 0=No*
Water Pump		
Ox-drawn plough		
Wheelbarrow		
Trailer		
Tractor		
Tractor-drawn plough		
Vehicle		
Cattle		
Goats		
Other		

C2. Are there any production assets supplied by the government? 1= Yes, 0= No
C2.1 If yes which ones: …….....

D. LAND OWNERSHIP AND UTILIZATION

Land type	Ownership	Estimated area utilized	The proportion of area not utilized
Homestead garden			
Dry-land fields			
Irrigation plots inside the scheme			
Irrigation plots outside the scheme			

* *ownership*:1=Traditional allocation; 2=Rented; 3=State supplied/owned; 4=Inherited 5=Owned 6=Given by relative 7= Other
Is it in your name? 1= Yes; 0= No

D1. How far is your homestead from the irrigation scheme?	
D2. Do you pay for land (if leased)? Yes=1 No=0 (Rands)	
D2.1. Are you satisfied with the fees you pay for land? Yes=1; No=0	
D3. How do you feel about your land size? 1=Too small 2=Just right 3=Too large	
D4 Rate the quality of your land for crop production 0=Poor 1=Average 2=Good	
• Water holding capacity	
• Drainage capacity	
• Resilience to degradation and unfavourable conditions	
• Low weed pressure	
• Sufficient nutrient supply	
• Salinity problems	
D5. Are you satisfied with the tenure security of your land? Yes=1 No=0	
D5.1. Are you permitted to sell land? Yes=1 No=0	
D5.2 Are you permitted to rent your irrigated piece of land? Yes=1 No=0	

E. SCHEME GOVERNANCE

E1. Please answer the following questions regarding the governance of SIS's

1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree

I am aware of the National Water Act of South Africa	
I am aware or have heard of the Natural Water Resource Strategy of SA	
I know what the government aims to achieve in SIS	
I know that I have to have a water licence to use irrigation water	
I am satisfied with how the land is allocated in SIS	
The terms of land allocation should change to suit farmer needs	
The rules regarding water allocation in the scheme are fair	
The rules set within the irrigation scheme are fair	
The rules in the scheme are hard to enforce	
Penalties for failure to comply with the rules are fair	
I am satisfied with the cooperation between blocks and farmers in the irrigation scheme	
Water users are always willing to contribute to the maintenance of infrastructure and equipment in the scheme	
I am satisfied with how water conflicts are managed in the scheme	
I am satisfied with the involvement of the Tribal Authority in the irrigation scheme	
I am satisfied with the involvement of the DAFF in the scheme	
I am satisfied with the involvement of the DRDLR in the scheme	
I am satisfied with the involvement of the DWAS in the scheme	
I am satisfied with the involvement of the government departments in the scheme	
I am satisfied with the involvement of NGOs in the scheme	
I am satisfied with the involvement of Farmers in making the rules	
I am satisfied with the current executive committee	
The election process of the executive committee is fair	
I am satisfied with the contribution of the traditional council in irrigation management	
I am satisfied with the traditional council's level of understanding of the rule in the irrigations scheme	
I am satisfied with the level of contribution of the traditional council in rule enforcement	
I am satisfied with the way that the farmers and traditional authorities work in the scheme	
I am satisfied with the youth's involvement in irrigation scheme management	
I am satisfied with the youth's level of understanding of the rules of the scheme	
In your opinion, why is the youth not actively participating in farming ……..	

E3. IRRIGATION WATER LAW	
Questions	**Response**
1. Do you have water rights? *1= Yes 0= No 2= I do not know*	
2. If Yes, in what form? *1= Water Licence; 2= Water permit; 3=Other, Specify……..*	
3. Do you have any constraints with due to the current irrigation water law(s)? 1=Yes 0= No 3.1. If Yes, what ……	
4. My access to water is secure *1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree*	
5. Have you experienced water conflicts in the past 12 months? *1= Yes 0= No*	

5.1. Between farmers	
5.2. Between blocks	
5.3. Between cooperatives	
5.4 If Yes above, what were the causes? 5.5 If Yes in **5** were the problems solved? 5.6 If Yes how?.....	
6. Do you pay for use of water? 1=Yes; 0=No. How much? • 6.1. If not paying, would you be willing to pay for water in the irrigation scheme? 1=Yes; 0=No • 6.2 If Yes much how much per month? • 6.3 If No why?.....	
7. Who do you think has the responsibility to ensure water availability Why?.....	
8. Do you belong to Water Users Associations (WUAs)? 1= Yes 0= No • 8.1 If no to 8 do you know any Water Users Associations (WUAs)? 1= Yes 0= No	
1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree	
• 8.2 If Yes in 8.1, the WUAs has improved water access in your irrigation scheme	
9. You are satisfied with the irrigation schedule	
10. Government participation in irrigation water management increases your feeling of responsibility to manage water.	
11. Private sector and NGO's participation in irrigation water management increase your feeling of responsibility to manage water	
12. Irrigation water laws are effective in the management of water resources	
13. Irrigation laws influence your decisions on resource allocation.	
14. Irrigation water laws influence your economic performance	
15. Irrigation water laws influence your cropping patterns.	

E4. INFORMAL WATER MANAGEMENT INSTITUTIONS	
1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree	**Response**
16. Are there appropriate rules existing in irrigation water management	
17. Mechanisms e.g. constitutions, to assist irrigation water management at scheme level exist	
18. The constitution is effective in the management of water resources	
19. Irrigation water policies are effective in the management of water resources.	
20. Informal water institutions are effective in the management of water resources.	
21. Informal water institutions affect your daily operation in the scheme.	
22. Informal water institutions influence your economic performance.	
23. You comply with the rules of the scheme	
24. The existing committee is effective in ensuring compliance to regulation on water uses	
25. Other water users understand the consequences of their actions in the irrigation scheme	

F. FARMER PARTICIPATION

Question	**Response**
F1. What role do you play in the scheme management? *1= ordinary member, 2= committee member, 3=Executive member, 4=Other; Specify……..*	

F2. If not participating: are you willing to participate in the scheme management? *1=Yes; 0=No*	
F3. If not participating, give your reasons? ……	

F4. What has been your level of involvement in the following activities for the past year (June 2016 – June 2017): *0=None (never involved); 1=Sometimes; 2=Always*

Activities	**Rank**
1. Financial based participation	
Contributing finance towards irrigation pump maintenance	
Contributing finance towards irrigation maintenance (buying material, paying the maintenance people, etc.)	
Contributing finances towards the Water Users`Association (WUA)	
2. Participation in decision making processes	
Attending irrigation meetings	
Attending irrigation/water related training	
Engaging authorities regarding water issues in the area	
Distributing information about water issues (written or verbal)	
Helping other farmers to manage/conserve water	
In electing/removing committee members	
In formulating rules in the scheme	
In irrigation water scheduling	
Other (specify)	
3. Participation in regulation and control	
Reporting unlawful behaviour (unauthorised handling etc,) Where do you report to?.....	
Reporting leakages along the canal for repairs	
How often do you attend water-related meetings (e.g. weekly, monthly, none, etc.)?	

(*1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree)*

F5. Participation in irrigation water management improves access to government support

F6. Your participation in irrigation management increase your feeling of responsibility to manage water?

F7. Your participation in water-related meetings help to lobby for local organizations to solve irrigation?

G. CROPPING AND MARKETING SYSTEM

G1. What crops do you grow, the area you planted, the output you produced and the costs you incurred.

Crop name	Area planted	Quantity harvested (kgs)	Quantity sold	Price per unit	Output market	Inputs used	Quantity Purchased	Cost per unit

Key

Crops	Market Outlet	Inputs used
1=Maize; 2=Tomatoes	1=Local shop	1=Fertilizers; 2=Herbicides
3=Potatoes; 4=Sugarcane	2=Neighbours	3=Labor; 4=Transport
5= Spinach; 6=Cabbage	3=Contractor; 4=Hawkers	5=Marketing; 6=Seeds
7=Beans; 8=Onions	5=Shops in town	7=Pesticides; 8=Tillage
9=Butternut; 10=Other (specify)	6=Other (specify)	9=Packaging; 10=Other (Specify)

G2. How often do you fail to sell your farm produce? *(Never=0 Sometimes=1 Always=2)*

……..

G3. How much do you make from your crops? R…….

G4. What cropping method do you use in your plot 1=Mono-cropping; 2= Inter-cropping; 3= Crop rotation; 5= Other

H. WATER AVAILABILITY AND IRRIGATION

H1. How many times per week do you have access to water in your plot(s)?	days
• H1.1 It is adequate? Yes=1; No=0 • H1.2 How many minutes/hours do you let water into your plot on your irrigation day?	hr/mins

H2. Please rate the extent to which you agree with the following statements pertaining to water access to your irrigation plot(s). (*1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree)*

Water is reliable	
I always get water in my plot(s)	
Water is sufficient for my cropping requirements	
I have the ability to pay for water and water-related services	
Water distribution/sharing at farm level is fair	

H3. Rate the amount of water you have received over the past 12 months. (1=less; 2=same; 3=more)

H4.1 If changed what is the reason for this?

……..

J: HOUSEHOLD INCOME AND EXPENDITURE INFORMATION

J1. Please indicate the amount spent per month on:

i. Food items R……..

ii. Non-food items (Electricity bill, toiletries eg soap, utility bills etc,) R……..

J2. What were the sources of your household income in the last 12 months? (Indicate approximately how much each source contributed and how often).

Household Income Source		Total amount (Rands)	Frequency (how often?)
Remittances			
Agri activities	Irrigation Farming		
	Dryland farming		
	Livestock production		
Permanent Employment			
Temporary Employment			
Welfare grants	Disability grant		
	Child grant		
	Pensioners grant		
Other (Specify)			

J3. Please answer the following questions

Questions	Response
Do you have access to credit? *1=Yes 0=No*	
Have you taken credit or used any loan facility in the past 12 months? *1=Yes 0=No*	
If Yes, what was the main source of credit? *1= Relative/ friend; 2= Money lender; 3= Stokvel; 4= Input supplier; 5= Output buyer; 6= Financial institution (specify name)*	
If No to 4, please specify the reason(s). *1= Loan not required; 2= Interest rate is high; 3= I couldn't secure the collateral; 4= I have got my own sufficient capital; 5= It is not easily accessible; 6= I am risk averse*	
If you took credit, were you able to pay back? *1=Yes 0=No*	
If No, please specify the reason	

K. PSYCHOLOGICAL CAPITAL

K1. What is your main reason for farming? (*1=Income 2=Extra food 3=Employment 4=Other*) …….

K2. You consider farming as a business and can be managed as such**? (***1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5= Strongly disagree)* ……

K3a**.**You are interested in expanding your farming operations (including increasing plots). (*1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5 = Strongly disagree) ……..*

K3b**.Why**?_____

_____

K4**.** Do you see yourself as a potential commercial farmer one day? 1=Yes 0=No ……...

K5. You feel confident to contribute to discussions about the irrigation scheme strategy. *(1= Strongly agree 2= Agree 3= Neutral 4=Disagree 5 = Strongly disagree)*

K6**.** How satisfied are you with the performance of the scheme? (*1=Very satisfied 2=Satisfied 3= Neutral 4= Dissatisfied 5= Very Dissatisfied) ……*

K7**.** How interested are you in being a scheme committee member? (*1= Very interested 2= Interested 3=Neutral 4= Slightly disinterested 5= Not interested at all) ……..*

K8. How interested are you in taking part in training in collective management of irrigation scheme? (*1= Very interested 2= Interested 3=Neutral 4= Slightly disinterested 5= Not interested at all*)
K9. When working in a group securing a sustainable use of resources for the future is important? (Yes=1; No=0).
K10. How high is your confidence in farming as a means to a sustainable livelihood? (*1 =Very high 2= High 3= Neutral 4= Low 5= Very low*) **……**
K11**.** How high is your confidence in yourself as a farmer? *(1 =Very high 2= High 3= Average 4= Low 5= Very low) ……..*
K12**.** Please indicate the extent to which you agree with following statements
(1=Strongly disagree=1 Disagree=2 Neutral=3 Agree=4 Strongly agree=5)

The government is not doing enough for the wellbeing of farmers	
I am optimistic about the future of farming in your area	
I am able to cope with natural shocks such as drought	
I am willing to go find a market if there aren't any available in my area	
I enjoy new opportunities	
I do not give up easily	
I am willing to take business risks	
I am willing to invest in farming and make a loss in the short-run in order to benefit in the long-run	
I have the power to affect the outcome of my farming	
I hope the quality of life will be better	
I trust other farmers	
I would not be farming If I had a better source of income	

L. SOCIAL CAPITAL
L1. Are you a member of any of the following groups?

Group	Membership (Yes=1; No=0)	Function
Cooperative		
Social group (church, stokvel, burial society)		
Other (specify)		

L2. Please rank the following sources of information relevant to your farming activities based on how you have used them in the past year (*eg, market prices, when to grow, where to sell).*
1=Unimportant 2=Neutral 3= Important

Extension Officers		NGO's	
Media		Private organizations	
Internet		Academic institutions	
Fellow Farmer		Traditional Leaders	
Community meetings		Cooperative	
Irrigation committees		Other (specify)	

M.CHALLENGES IN SIS
(1=Strongly Disagree; 2= Disagree; 3= Neutral; 4=Agree; 5=Strongly Agree)

There are not enough plots available in the scheme	
Irrigation scheme is too far from the homestead	
People use water illegally in the scheme	
There is a lack of market access for farm produce	

Farmers are not willing to pay for water use	
People benefit from irrigation water but do not participate in the scheme	
Infrastructure is in poor condition	
There is inadequate water supply in the scheme	
There is unauthorised handling of water control infrastructure	
I am not satisfied with the condition of the infrastructure	
Management does not commit to infrastructure upgrade, rehabilitation and maintenance	

In your opinion, what causes infrastructure damage?

.....

THANK YOU/SIYABONGA

APPENDIX 2: GUIDELINE FOR FOCUS GROUP DISCUSSION AND KEY INFORMANT INTERVIEWS

UNIVERSITY OF KWAZULU-NATAL

School of Agricultural, Earth and Environmental Sciences

Discipline of Agricultural Economics

Effects of interactions between governance, intergenerational and gender dimensions on smallholder irrigation scheme in KwaZulu-Natal, South Africa

Farmer Discussion Guidelines

1. Are you aware of water policies affecting irrigation schemes in South Africa?
2. Are you aware of the strategies set by the government for Smallholder Irrigation Schemes (SISs)?
3. Are there any strategies being implemented in this irrigation scheme?
4. Are you aware of land policies affecting SISs?
5. What are the rules regarding land allocation? Who is responsible for land allocation in this irrigation scheme?
6. What are the rules regarding water allocation? Who is responsible for water allocation?
7. What are the general rules of this irrigation scheme? Who is responsible for the operations (cleaning, water scheduling, etc.) of the scheme?
8. What are the agreements on users that violate the scheme rules?
9. What are the rules regarding farmer participation, who attends the meetings, who elects the farmer representatives?
10. What are the rules in selecting or removing a new representative committee for farmers in the scheme?
11. What are the scheme rules regarding the conflict between users?
12. What are the rules about water access in the scheme? Who regulates water access?
13. Which governmental bodies engage with farmers in SISs and how? What are their roles?
14. Which other stakeholders are involved in the scheme and what are their roles?
15. What are the rules in getting water licenses and permission to occupy?
16. What are the rules in selecting or removing a new representative committee for farmers in the scheme?

APPENDIX 3: ETHICAL CLEARANCE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

12 February 2018

Ms Senamile Fortunate Dlangalala 211502265
School of Agricultural, Earth and Environmental Sciences
Pietermaritzburg Campus

Dear Ms Dlangalala

Protocol reference number: HSS/0067/018M
Project title: An assessment of the effects of the interactions between intergenerational and gender dimensions with governance on the economic performance of irrigators in smallholder irrigation schemes

Full Approval – Expedited Application

In response to your application received 25 January 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Dr Shamila Naidoo (Deputy Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

cc Supervisor: Dr M Mudhara
cc Academic Leader Research: Professor Onisimo Mutanga
cc. School Administrator: Ms Marsha Manjoo

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Founding Campuses: Edgewood, Howard College, Medical School, Pietermaritzburg, Westville